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In Honor of

RICHARD M. BOHART

on the Occasion of his 70th Birthday

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CONTENTS FOR VOLUME 59

PAN-PACIFIC ENTOMOLOGIST
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IN HONOR OF

RICHARD M. BOHART

ON THE OCCASION OF HIS 70TH BIRTHDAY

Dick Bohart has been a member of the Pacific Coast Entomological Society for nearly half a century, and the Society takes great pleasure in dedicating this issue to him on his 70th birthday, September 28, 1983.

R. M. Bohart, April 1973 at Davis. Photograph by Carll Goodpasture.

Preface

This special issue of the Pan Pacific Entomologist *had its inception about two years ago when we realized that Dick Bohart was approaching his 70th birthday. In view of his outstanding career in entomology both as scientist and teacher, it seemed appropriate to commemorate this event by dedicating an issue of the journal to him, an issue filled with papers by his students, colleagues and friends. All of us wish Dick well on his special natal anniversary and hope he will have many more productive years with his beloved wasps.*

The biography that begins this issue is not the usual type that accompanies "Festschrifts." It is a multi-author concoction filled with anecdotes, plaudits, humor and history. We have invited friends and relatives to write about their remembrances of Dick; asking each one to cover a certain period in his life. A summary of his impact in the scientific community, his qualities, accomplishments, and a bibliography of Dick's publications conclude the biography.

We have had help from a number of people in putting this issue together. Dave Smith gave us insight into the world of copy editing. The following helped us with biographical and bibliographical material: Lionel Stange, George "Ned" Bohart, Roy Snelling, Frank Parker, Bob Bechtel, Patti Paige Adams, Margaret Bohart, Bob Schuster, Bob Washino, Lynn and Bob Kimsey, Norm Smith and Ev Schlinger. To all these people we extend our thanks.

Arnold S. Menke and E. Eric Grissell
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Washington, DC 20560

A Biography of an Entomologist

R. M. Bohart—A Brother's Perspective

G. E. Bohart[1]

Dick's artistic talents are among my earliest recollections. I suppose he was 8 and I was 5 when I went from door to door in Washington, D.C. selling little dishes he made from clay we dug from the street in front of our house. I recall them as being handsomely decorated with clover leaf designs made from different colors of clay. He retained this interest for many years. In his high school and early college days, he made clay models of his own concepts of futuristic autos, of animals in San Francisco's Fleischacker Zoo, of my head, and of female figures discovered in magazines. The many items were made from clays we dug out of the Berkeley hills and, although they were never fired, some of them still remain in his home as *objets d'art.*

His budding scientific interests were manifested early by experiments with quick cooling of red hot clinkers taken from the furnace and dropped into the toilet. I can still see our cat with her kittens swimming around in the flooded basement that resulted from this experiment. Another endeavor involved anaesthetizing the same cat with illuminating gas. Fortunately, she survived both ordeals.

Besides his talents as a sculptor and scientific experimenter, he was a candy maker of no mean ability. On one occasion during his teen years he made a huge batch of fudge on the "QT." Suddenly, he spied mother coming home early. The pan full of fudge went onto a pile of furniture stored behind a curtain in our basement butterfly collection workshop. Since the candy was snatched off the stove too soon, it never completely hardened and, weeks later, after the pan had been accidentally jostled, mother spied a glacial tongue of fudge creeping out from behind the curtain. The furniture was kind of sticky but mighty sweet and tasty.

Dick was indeed a "man for all seasons." During his high school years, he and I used to fire a football at each other's heads at close range. This led to throwing it for distance on a course we measured out on the street. Finally, it led to his competing in the annual football team kick and throw contest. It must have been embarrassing for the team and its coaches when Dick, as a sophomore in street clothes, won the throwing event against the team's star players. His name was engraved on the silver trophy cup, but when he won the event the second year in a row, someone dropped the cup and broke it. That was the end of this contest at U.C. You can draw your own conclusions from this story.

Early on, Dick developed a keen appreciation of the female form. I believe it was in his early teens that issues of "Paris Nights" and similar magazines began turning up in various hiding places around the house. At first I was very shocked and felt sure that he was destined for hell fire and damnation. However, before very long, I, too, began to appreciate the attractions that lay between the maga-

[1] Bee Biology and Systematics Laboratory, ARS, USDA, Utah State University, UMC 53, Logan, Utah 84322.

zine's covers. His interest was not restricted to graphic representations. For example, I recall two young ladies up the block whose bedroom window faced ours. Since they sometimes failed to pull down the shade, Dick began to make some careful studies which resulted in his rather sexist nicknames for the girls, PPB, for pretty pink bottom and PBB, for pretty big bottom. I cannot affirm or discredit the accuracy of his designations since I could never get my hands on the field glasses during critical observation periods. However, his subsequently demonstrated ability to discern minute distinguishing differences between insects leads me to believe that he did not let his excitement interfere with the accuracy of his observations.

Paleontology was another of Dick's youthful interests. For example, when, as a college freshman, he got a job as caretaker of a duck hunting club on Point Reyes, he found dozens of Miocene marine fossils along a lonely stretch of beach. He brought back numerous cetacean ear bones and several skulls of a dolphin subsequently described as *Echinorhynchodelphus pontereyensis* by a professor in the Paleontology Department. A monstrous whale skull imbedded in the beach had to remain there. Rowing back to the clubhouse with his trophies, he spotted some pine cones protruding from a sea cliff. Dr. Mason, the paleobotanist at U.C., was very excited with this find since it helped him develop a revised concept of pine speciation and distribution in coastal California during the Pleistocene.

"Rock hounding" was a hobby we both carried on with our father who was a research chemist, but more significantly to him, a frustrated would-be mineralogist. In 1926 we drove our old Hupmobile through Oregon and Washington collecting agates from every gravel service station driveway encountered. We also scoured such favorite rock hound haunts as Agate Beach and the Medford lava beds where plenty of "good stuff" could still be found. In later years, when Dad put together a lapidary outfit, Dick, with his ready eye for symmetry, gave the initial shape to most of our "gems." I smoothed out the little ridges and flats, and Dad, whose eyesight was not the best, did the polishing. I still have some polished stones that Dick found in such far away places as our junior high school playground in Berkeley and the dry bed of Putah Creek near Davis.

I should say something about Dick's early experiences in entomology. Although I claim to be the first of us to start collecting butterflies (at age 7), he soon "took over" as big brother. We developed a great proficiency at picking "silverspots" and swallowtails from butterfly bushes (*Buddleia*) with our hands without damaging the scale patterns. After moving to California, Dick vowed that we would collect every kind of butterfly in the State. We had to sell a number of rare "aberrations" to a wealthy amateur lepidopterist named Gunder before we could finance trips to southern California to collect such rarities as the Sonora Blue and the Pima Orangetip.

Dick's final transition from butterfly collecting to a more scientific endeavor took place while he was making an insect collection to satisfy requirements for the U.C. field course in Entomology. He found a bee (*Andrena*) with an odd triangular plate protruding from its abdomen. He pulled out a sack-like parasite that soon produced a state of confusion in the Entomology Department. Dr. W. B. Herms sent Dick to the Zoology Department where Dr. Sol F. Light pronounced that it was not a helminth. Professor E. O. Essig recognized it as an insect and suggested showing it to Dr. E. C. VanDyke, a noted coleopterist. He recognized it at once as a female *Stylops* (order Strepsiptera) and excited Dick's interest in the group to the point that he continued studying Strepsiptera and eventually made them the subject of his Ph.D. thesis.

R. M. Bohart—A Wife's Perspective

Margaret E. Russell Bohart[2]

I have been asked to make a few comments about our early life together. I am stunned to realize we have been going together fifty-one years. We've kept so busy I guess we haven't noticed the passing of time.

Dick and I met at Cal-Berkeley the fall of 1932, and I was soon following him across the Berkeley hills and Antioch sand dunes as he pursued his interest of the moment, butterflies and Strepsiptera. I have to admit that I was rather embarrassed to be seen with this big guy swinging a butterfly net, but I outgrew that, and in the end I have drawn my own snickers from young boys, as I, that gray-haired lady under a pink flowered hat, swept up the wasps in an Argentine wash.

We were married Jan. 4, 1939 and settled in West Los Angeles where Dick was teaching and doing research at UCLA. For me the fun came from the collecting trips, and I was lucky enough to go on almost all of them. From Los Angeles we had weekend camping trips to the Mojave and Borrego deserts, and sometimes longer ones to the High Sierra, and the Grand Canyon of Arizona. After a couple of years I tried my hand at collecting, as there was a limit to how much needlework I could do. I missed a lot of "bugs" in those days, and I never learned to pinch the thorax. I have my own technique.

One of Dick's research projects at UCLA was the sod webworm that was destroying lawns. At one point we went out every night, all night, every hour on the hour, to a private lawn to lie prone on the grass and, with the glow of a flashlight, watch the worms snip off tender shoots and haul them back into their homes. We also poured a solution on one square foot of sod, and then counted the worms that rose to the surface. Great way to catch a cold.

In the early spring of 1942 our Los Angeles apartment burned. While it was being redecorated we took a trip to Yosemite. We hauled his papers and typewriter along. I'm the typist. One evening we were walking across a little bridge and a mosquito got in Dick's way. He examined it and then dashed it down, saying that was one thing he was never going to work on. Fate interfered.

November 1942 Dick was drafted into the Army, but with some agile footwork he got himself into the Navy as an Ensign, and by Dec. 5 we were at the Marine base, Camp LeJeune, Jacksonville, North Carolina. He was to teach malaria and mosquito control. A few months later he was transferred to Camp Perry, Williamsburg, Virginia to do the same. Two thousand in a class, a new class every five weeks. That's where he got that voice heard a mile away. We didn't have a car so our collecting trips were small walks through the lovely woods. Of course

[2] 230 Shepherd's Lane, Davis, California 95616.

chiggers, sudden rain storms and humidity were something we had never had to reckon with before. We enjoyed Williamsburg and all its history.

In the early spring of 1944, Dick was transferred to Washington, DC and assigned to Naval Medical Research Unit #2 housed at the National Academy of Sciences. Almost immediately he and his brother, Ned, and Ken Knight were sent to Orlando and Tallahassee, Florida, where Dick studied mosquitoes under Dr. Boyd. We stayed a month and then returned to Washington. Thus mosquito taxonomy began in earnest and Dick was in his element. We spent our free time at the Mellon Art Gallery and the Smithsonian. Couldn't ask for anything more. At this point he tried to make a taxonomist out of me, studying the bee genus *Nomadopsis,* but it didn't take. Ned, Ken Knight, Alan Stone, Karl Krombein and other taxonomists were in DC as well as some of Dick's cousins, so we enjoyed the stay very much.

It was time to go overseas and in the fall of 1944 Dick was assigned to Guam and then Okinawa, for malaria control, and I returned home to Fullerton, Calif. Dick took with him all the equipment and photocopies of the literature necessary to carry on the study of mosquitoes in those islands. Stan Bailey was working with him, and they had good luck in cleaning up the mosquito problems of Guam.

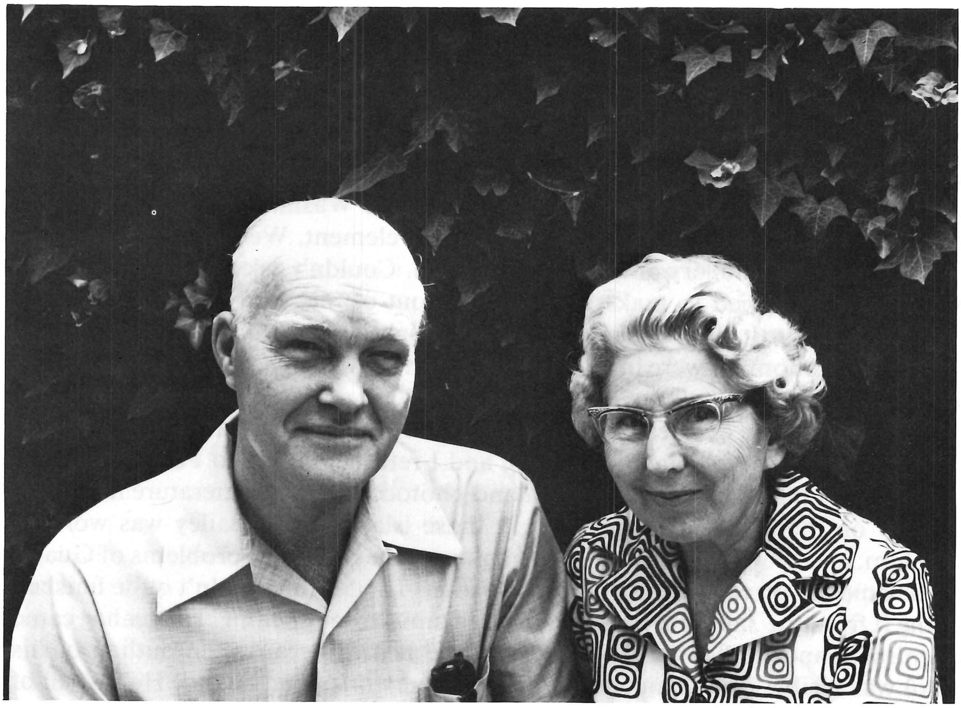
They moved on to Okinawa a little too soon. The Marines hadn't quite finished taking it from the Japanese and Dick landed amid some shelling. His seabag came up missing and he figured it was tossed overboard, because the outline of his pistol was visible, and someone wanted the gun worse than he did. He lost all of his equipment, literature and clothes, but fortunately nothing more serious occurred. Despite occasional pot shots from the Japanese, who were still holed up in the hills, he seemed to really enjoy Okinawa, its beautiful beaches, fine swimming, and of course the insect collecting. Funny things happened, too. One of the responsibilities was to eliminate mosquito larvae by covering any standing water with xylene or a similar chemical. This assignment included outhouses. Yep, someone dropped a lighted match and blew the place up, but luckily only his dignity was bruised.

Dick could have been released from the Navy in the fall of 1945, but he agreed to stay on a few more months to get his research written up, thus we returned to Washington. We worked at the Academy every night. I did lots of typing of literature, as Dick was collecting material for other projects. Photocopying was still somebody's dream. Somewhere in these years Dick wrote the "Mosquitoes of the Philippines" (published in 1945), from specimens sent from the field.

The project came to an end, and Dick was released from the Navy in the spring of 1946 with the rank of Lt. Commander. We returned to California where his position at the University of California was waiting for him. He transferred from the UCLA campus to the Davis campus, arriving there July 1946.

A new branch of life started that came to involve many students, particularly graduate students with whom we came to have a close, personal contact. With retirement I think we miss this the most. The research and the trips to the Hawaiian and other Pacific Islands, Japan, British Isles, Western Europe, East Africa, Natal, South Africa, Argentina, Brazil, Costa Rica, Venezuela, Mexico, Australia, Canada and the United States, especially the beloved southwest, were a part of these years, too. And the gleam in the eye for another trip has not disappeared.

Just so the modern girls won't think I had no life of my own, I will tell them



Richard and Margaret Bohart at their home in Davis, July 1975. Photograph by Woj Pulawski.

I was a social worker, and had [and still has—edit.] an all absorbing hobby, genealogy. We also entertained a great deal, played a lot of bridge, and raised Pepe Le Moko, Annabel and Miss Bo, who would not like being left out. Those three kittens were with us a total of thirty-one years.

I think the greatest thing has been that Dick was lucky enough to find an occupation in this life that he has thoroughly enjoyed.

Some Remembrances of the Early U.C. Davis Days, 1946–1956[3]

Ev Schlinger[4]

Although I didn't know it, when I arrived at U.C. Davis in February 1946 as a 17-year-old budding entomologist, I arrived a full four months before my future major professor, Assistant Professor Richard M. Bohart. This was a time, near the end of World War II, when U.C. Davis had about 100 students, only one of whom was a woman. Needless to say, she was well escorted!

[3] Thanks go to Bob Bechtel for supplying some of the memories recorded here.

[4] Department of Entomology, University of California, Berkeley, California 94720.

The first "post-war" Introduction to Entomology class (Ent. 1), a 5-unit semester course, was to be taught in the spring of 1946 by Drs. W. Harry Lange, Jr., and the late E. M. Stafford. There was a total of seven students in the class with two of us majoring in Entomology and two professors to teach us. What a student-teacher ratio.

In the spring of 1947, as I remember it, when "Doc" was asked to teach this Ent. 1 course, he asked several of us "older" students to go along on a field trip to the Sierras with his class to help collect insects to start to build an insect teaching collection. I clearly remember that day when he warned all of us not to drink the clear mountain water as it might be unsafe. It was a hot day, no large animals were evident, and we just had one quick drink of the cool mountain water—only to come down with dysentery the next day. I have never told Doc about the dysentery, but I learned to take his words more seriously and eventually became one of his first graduate students.

When I entered graduate school in the fall of 1950, there were six graduate students, all of whom were under the late Dr. Stan F. Bailey, head of the department. I well remember how Dr. Bailey insisted that each of us come to see him at a specified time each Saturday morning to discuss our research with him. He wouldn't discuss research with us during the week, and needless to say, we would much rather have been allowed to go collecting, or . . . Bailey insisted on being responsible for all taxonomy grad students, but about six months after I entered grad school Doc was permitted to have his first students. That was when R. C. "Bob" Bechtel, A. D. "Biff" Telford, and I chose to work with him. In those days, the graduate students had offices in the "quonset" building next to the Entomology building. This was an army surplus, metal, pre-fab structure, which, although freezing in the winter, kept us and our insects dry.

At that time, Doc was working on at least three separate projects; i.e., (1) Taxonomy of Culicidae, (2) Taxonomy of Vespidae, and (3) the California Cherry Tree's insects and their control. He was also very much involved with working up and collecting sphecid wasps. He took the three of us in stride even though all of us had chosen thesis topics quite different than his; i.e., Bechtel had chosen to work on Plastoceridae, Telford had chosen to study diapause phenomena in marsh mosquitoes, and I had chosen the biology of spiders and their parasitoids. Doc tried hard to turn Bechtel and me into "Hymenopterists," and by allowing us to help prepare and publish papers with him (Bechtel on California social Vespidae and myself on California *Oxybelus* wasps), he taught us considerable about taxonomic methodologies and Hymenoptera. Bechtel went on to study the family Sapygidae, Telford eventually took on the chrysidid genus *Parnopes,* but I finally settled on a taxonomic revision of the Acroceridae (Diptera). Jack Hall and Bob Washino eventually joined Doc's group as master's candidates working on bombyliid flies and mosquitoes, respectively.

The years 1950–1956 were exciting times for us, and other than hard day-to-day laboratory revisionary work and field sampling, I think the events I remember most were the special field collecting trips. Locally, in those days, Putah Creek was close by and contained between its banks some most interesting insects. Doc was able to join these trips frequently and even more often in the higher Putah Canyon area, especially around Monticello near Pope Valley, with Samuel Spring the favorite site. This latter locality, now covered by waters of the government's massive project called Lake Berryessa, became the type locality of a number of his new species.

Other events remembered well were Doc and his competitive spirit on our Departmental Softball Team which, by the way, we won most of the time, and our "horseshoe" games after work just outside his office in the "old" one-story Entomology building. Badminton was also one of Doc's favorite pastimes and he was instrumental in the establishment of the "Davis Badminton Club," of which he became president.

Those were wonderful years for all of us, and I am pleased to have been lucky enough to have had the guidance and tutorship of one great guy and excellent entomology professor, Dick Bohart.

Memories of "Doc"—1956 to 1967

Arnold S. Menke[5]

My first exposure to "Doc" was on the entomology summer field course, Ent. 49, in 1956 at Tanbark Flat in the San Gabriel Mountains of southern California. It was the second time he had been in charge, having first led the course in 1954. Margaret accompanied him as did Bob Bechtel, the latter serving as his assistant. Some of the students who took the course that summer were Lionel Stange, Mel Sparks, Jerry Stage, Louie Shainberg, "Hal" Moffitt, Dick Bushing, "Hank" Michalk, Art Bartels, and Beverly Bartosh. I remember well the noxious rhagionid biting flies at Tanbark Flat which made collecting around camp miserable at times. Breakfast for Doc always seemed to be "Special K" and lunches often were the infamous peanut butter and jam sandwiches. I recall that Doc had a large disdain for milk claiming that it was only for kids. He used to tell us that it made adults prone to colds and other problems. Instead Doc drank Pepsi or buttermilk, the last being something of a contradiction. We could never understand how he could drink that stuff.

Doc impressed all of us as a tireless collector, and he always put in a full day of collecting. By his example and instruction we learned the many special techniques necessary to collect various kinds of insects. He was always stressing that we should not just collect big showy beetles, wasps and butterflies, and he expected everyone to catch small insects that required point mounting. During the evening while we were pinning up our material, he would come around to see what we had caught, and I recall his frequent question: "where are all the small Diptera?" Doc alerted us to the tiny sphecids and other wasps that were found on the ground and which required the "clap" technique to capture. He also drew our attention to the wondrous nannofauna that frequented mat *Euphorbia* and other prostrate plants that most of us would otherwise have ignored completely as potential sources for insects. In his own way he was always stressing observation. I remem-

[5] Systematic Entomology Laboratory, IIBIII, ARS, USDA, % U.S. National Museum of Natural History, Washington, D.C. 20560.

ber when he broke off a plant stem that had blooming dodder entwined around it, showed it to some students, and asked if they knew what kind of plant it was. Of course he was hoping to trick them into thinking that the dodder was part of the plant stem, but at the same time he was pointing out that there was always more to things than met the eye at first glance. He also took the opportunity to emphasize that dodder blossoms attracted some interesting insects. Doc always seemed to be able to collect more of anything than anyone else. I remember catching a couple of rhipiphorids on an *Eriogonum* plant, the first of these beetles I had ever seen alive. Naturally I took my prizes over to Doc to show them off. To my chagrin and amazement he produced a vial containing a dozen or more rhipiphorids, telling me with a rather straight face that "they were revolving slowly in a mass on a single *Eriogonum* blossom." That was his sly style of humour.

Lionel Stange, my pseudo-brother and collecting chum, possessed an old 1947 Studebaker which he and I used during the course for weekend forays to collect insects at distant favorite collecting haunts like Blythe on the Colorado River. I think that Doc secretly enjoyed our initiative, but I know that we also caused him some concern and problems. We always brought back stuff that no one else in the class had seen and that engendered some jealousy among fellow students. Also Lionel's car was approaching a basket case. In fact it did die one night when Lionel and I were driving down to Glendora. On a hairpin turn on that long winding mountain road the right front axle snapped bringing us to a grinding halt short of the dropoff. Doc was not too happy when we arrived back at Tanbark Flat late that night courtesy of the Glendora police.

Doc had some very definite ideas about how insects should be mounted and labeled. He always used #2 pins, and we marveled at his disdain for point punches. He would cut his points from strips of paper with scissors. Doc insisted that insect labels not exceed 12 mm in length, nor be more than 5 printed lines. During the course Lionel Stange and I ran the label printing press instead of washing dishes.

My next encounter with Doc was at his invitation. In the Spring of 1957 when I was finishing up my senior year at Berkeley and contemplating grad school, he wrote to me asking if I would be interested in being his Research Assistant at Davis to help him with teaching general entomology and systematic entomology. To quote from his letter, "each of these jobs . . . [offers] . . . the finest possible experience for an entomologist." I had visited the Davis campus several times and liked the country atmosphere and small student body (about 2000) far better than the Berkeley fog and zoo, so I jumped at the opportunity. Thus Doc acquired a water bug (belostomatid) lover. When I arrived at Davis in September, 1957, he had just become Department Chairman.

Helping Doc with the labs in these courses proved to be a great experience, and looking back on those days now, I realize that in the taxonomic course, especially, he accomplished something that is missed in many such courses: he taught people practical, everyday, taxonomic procedure, the real world of nomenclature and how you deal with it, how descriptions and keys are written, how illustrations are rendered, and how you put it all together in a publishable paper. Truly a rare experience for those fortunate to have taken his taxonomy course. As he admitted in his letter to me, "we run 112 [taxonomy] somewhat differently from Berkeley. The student takes a special problem under close supervision of the lab instructor and staff member." Each student actually did a miniature (some not so small!)

research problem starting with a box of insects, usually representing a genus in a family of Hymenoptera. The specimens had to be sorted to species and identified (or declared to be new which was not infrequent), described, illustrated, a key to them constructed, and the whole thing written up as a publishable paper.

Some students did in fact make valuable contributions and discoveries in Ent. 112 which they subsequently published, or which later blossomed into thesis problems. For example, Paul Marsh discovered a new species of the sphecid genus *Prionyx* which Doc later described and published as *subatratus.* Frank Parker discovered excellent mouthpart characters that easily separated the very similar females of two species of *Prionyx.* Frank subsequently published his findings which essentially made Doc's own recent paper on the genus obsolete. The chrysidid genus *Omalus* was revised by Doc and Luciano Campos subsequent to the latter's discoveries while working on the genus in Ent. 112. As for myself, lab instructor, I became enamored with the sphecid genus *Ammophila* which Dick James was working with in the course. He discovered a new species which I eventually described as *formicoides,* and I eventually revised the genus for my Ph.D. thesis.

Doc's exam questions in taxonomy were famous. They always included at least one thorny nomenclatorial question to solve, and he often had a number of obscure terms to define, some of which bordered on craziness (hypodigm, cheironym, natio, for example). Some of his questions were so subjective and broad in scope that they were a bear to grade.

General Entomology lab involved identification of insect orders and common families, and included a number of afternoon and weekend collecting trips. An identified collection of a considerable number of orders and families was a prerequisite to passing. Doc always took a shine to the ever present girls in his classes, and I recall that he tended to be lenient toward them at grading time.

In 1959 I was Doc's assistant on Ent. 49 which was held at the University of California's Santa Barbara campus located at Goleta. Doc also brought along Paul Marsh who was "selected" to run the label printing press. Possibly this was the most popular summer field course ever because of the nearby beaches to which most of us fled in the afternoons. Sunbathing, body surfing, and swimming made for great tans, but we discovered early on why they drill for oil offshore. Removing tar from feet after a trip to the beach became routine. We lived in a fraternity house, the only time most of us, especially the women, had such an experience. The men's john was a single large room with a number of unenclosed toilets along one wall. Nothing like communal elimination. Among the students taking the course were Frank Parker, Gene Cherry, Patti Paige, Meredith Bruck, Wally Steffan, Jim and Jack Bath, Ray Spore, Craig Campbell, and Bob Granados. Collecting near the beaches was generally very good for wasps such as *Ammophila,* and Doc discovered an *Oxybelus* nesting site adjacent to a lagoon behind the beach. He assigned the task of watching *Oxybelus* nesting behavior to Paul Marsh. I well remember how Paul spent many days sitting in the hot sun watching the wasps' activities while the rest of us hit the beaches for aquatic sports. Paul's observations were subsequently published in collaboration with Doc and that was Paul's first paper. One day Doc borrowed my VW beetle for a collecting trip. Reports I got from those that accompanied him suggested that I was lucky that the gear box was still intact after he returned.

Frank Parker and the girls had an interesting experience one night. There had been a "private party" in the girls' room. After the other participants had gone back to their respective sleeping quarters, a student, who shall remain nameless, returned to the girls' room around 2 AM thoroughly inebriated. The girls asked him to leave and he subsequently fell down the stairs suffering a large, deep gash on his forehead in the process. He was bleeding profusely and Patti sought Frank Parker's help. She found his room in the dark and woke him up. They got him into Frank's car, and Frank and the two girls drove to the campus infirmary. The nurse on duty called the police after seeing the student's condition. By chance the police were looking for two guys and two women who had been causing some disturbance in town. They took everyone to the police station for questioning. Somehow Meredith and Patti, dressed in nightgowns, eventually convinced the police to release them. They were taken back to the fraternity house in the wee hours of the morning just in time to pretend to be getting up in preparation for that day's scheduled field trip. When Doc saw the fellow that morning with all his stitches he was naturally concerned. Doc was told that the student "ran into something in the dark" and that the wound was not serious. As far as I know, Doc never knew the true story of that wild night.

The late 50's and early 60's saw Doc's graduate student load mushrooming. Paul Marsh was working on braconids, Helen Court was working on crabronine sphecids, Frank Parker was working on astatine sphecids, Byron Chaniotis and Fred Iltis were working on mosquitoes, Chet Moore was working on chrysidids, Lionel Stange was working on ant lions, and I was doing a master's thesis on a genus of Belostomatidae. Obviously Doc didn't insist that his students take on thesis problems in the area of his first love, the predatory wasps.

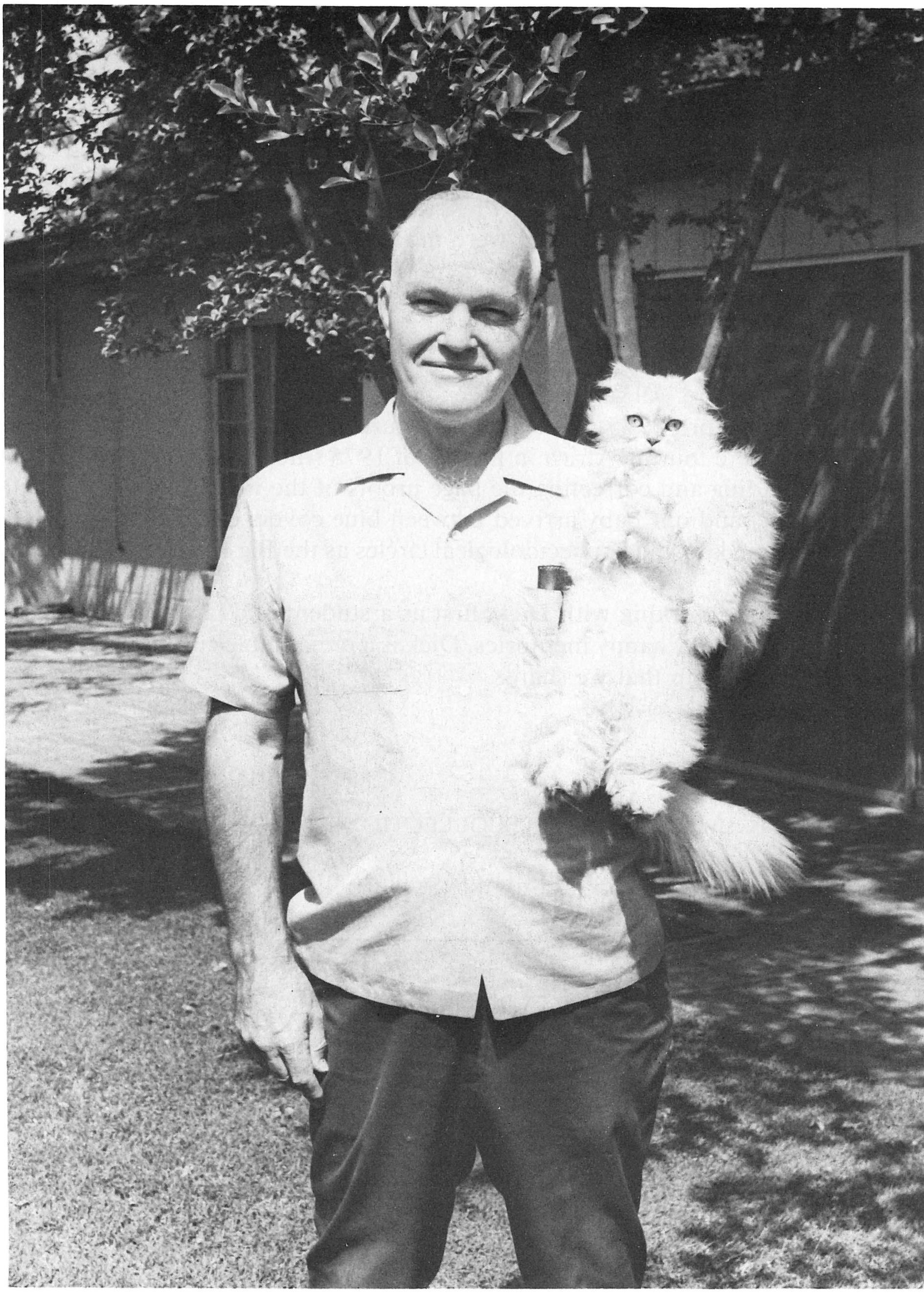
Another aspect of his graduate student guidance that is noteworthy was the rather limited amount of it. He tended to let his students pursue their thesis work without much inspection of progress, etc., at least after initial discussions of procedure. This meant that a student without strong inner drive (someone other than a "born taxonomist") would probably not survive long. This aspect of Doc's tutelage developed independence, discipline, and self initiative. The last is perhaps exemplified by the fact that his students often published papers on various taxonomic projects "on the side" during their graduate tenure. They were able to do this in part because Doc only expected his Research Assistants to teach laboratory in his courses. Rarely did he ask his RA to do anything else. Thus the rest of your time was free for other pursuits.

Doc commonly took on one of his students as junior author on some taxonomic research problem. In my case I first worked with him on the sphecid genus *Palmodes,* one of the spinoffs of Ent. 112. What an experience! (and not unique to me): while looking at specimens under the microscope he verbally described the creature, and I wrote it down to produce the description. That is not to imply that I did not do some looking at material myself. In fact, in this and all subsequent projects on which he and I collaborated, I was always impressed by the fact that he would listen to and often agree with my ideas and viewpoints on various matters. No one could accuse him of being dogmatic, stubborn maybe, but not inflexible. An example of his continued growth as a scientist was his change in attitude on subspecies. He was from the school that made every geographic color form a different subspecies, but in later years he came to appreciate the clinal nature common to many of these forms and his formal naming of them steadily decreased. This change in philosophy was influenced in part by his students which emphasizes his willingness to listen to new ideas. His de-emphasis of subgenera in favor of species groups in later years is another example that comes to mind.

The research for and writing of the book "Sphecid Wasps of the World" by Dick and me occupied a big chunk of both our lives—nearly 10 years in fact. Perhaps it is appropriate here to review a little of its history. While I was finishing up my Ph.D. thesis on *Ammophila* in 1965, Doc suggested that he and I collaborate on a revision of the North American genera of Sphecidae for which he would seek NSF support. Naturally his proposal appealed to me. After some thought I suggested that from the standpoint of producing a viable classification it probably would be better to expand our horizons. He agreed, and at first we set our sights on a generic study of the Sphecidae of the New World. In the initial stages of our NSF supported study we soon realized that only a worldwide revision would produce a sound classification for the family, and that became our ultimate goal. Our game plan was to divide the work between us, each having responsibility for researching and writing up a number of the subfamilies. Of course we had help from Doc's students, past and present (Frank Parker, Dick Brumley, Lionel Stange, Helen Court, Eric Grissell, among others), and colleagues (Wojciech Pulawski and Jack van der Vecht in particular), but the main input was ours. Dividing up the work between us may have resulted in some unevenness in treatment but it was the only logical way to handle the immense job before us.

Initially Dick assumed that we could finish the project in about three years, but expansion to a world study made this an impossibility. I don't think either of us (or anyone else that has tackled such a project) had any idea of the millstone we were putting around our necks, nor the time it was going to take to remove it. I worked on the project at Davis for three years until the NSF grant expired, at which time I was forced to find employment elsewhere, namely with the Systematic Entomology Laboratory in Washington, DC. My added responsibilities slowed me down some, but Dick plowed forward with his usual determinedness. I suspect that with my departure he probably worried some about keeping the whole project going at a steady pace, especially with my propensity for getting sidetracked on details. As I wrote up various sections I would forward rough drafts to Dick and he would have them typed up. We kept in touch mostly by frequent telephone calls, and fortunately I was able to visit Davis each year for periods of two to four weeks. During these visits he and I accomplished a tremendous amount of work. On one such trip we jointly worked up the Ampulicinae, and on another we did most of the introductory chapters for the book. He made one trip to Washington which gave us another opportunity to work together on the book.

By the spring of 1972 most of the taxonomic sections of the book were finished, and in May of that year we showed parts of it to the editors of the University of California Press which we hoped would publish it. They gave us tentative acceptance and we set Sept. 1 as a deadline for ourselves to complete the whole book. Dick was the instructor on Ent. 109 (formerly Ent. 49) that summer at Sagehen Creek and he spent much of his time during the course going over completed sections checking for consistency, errors, and making improvements rather than collecting. He was otherwise kept plenty busy the rest of the summer finalizing the subfamily Crabroninae, the last unfinished taxonomic section of the book. He was also saddled with the job of arranging all the plates of figures and making



Dick and Princess Silver Bow at the Bohart residence, Davis, April 29, 1973. Manuscript for the Big Blue Book had just been completed! Photograph by Arnold Menke.

sure that figure numbers were entered in the ms. correctly—a horrendous task. I busied myself with rendering drawings for my subfamily sections, checking species checklists in the Crabroninae and Nyssoninae, writing up the catalog of generic names and their synonyms, solving last minute nomenclatorial problems that required ICZN petitions, surveying last minute morphological discoveries subfamily by subfamily, and other odd jobs. Sept. 1 came and went, and by the end of 1972 the book remained unfinished. A shortage of secretarial help at Davis was partly responsible and this caused Dick to rent a typewriter and hire a typist with personal funds in early 1973 in order to get the monster finished. We finally got the completed manuscript to the Press around May 1, 1973. Publication was then only three years away! Ahead were months of proof reading by Dick and Margaret at his end, and by Karen and me 3000 miles away. Generally Karen and I read the proofs first and then forwarded them to Dick for his turn at them. Karen Menke also did the horrendous job of typing up all of the more than 14,000 3 × 5 cards for the taxonomic index, one name to a card. Dick took care of general indexing, also a chore. All galleys had been proofed by mid 1974, and page proofs were received in April 1975, reviewed and returned promptly. Later, while Dick and Margaret were touring Africa in the fall of 1975 (those lucky dogs!) I had the pleasure of reading and correcting the page proofs of the index! At last the millstone was gone, and our baby arrived between blue covers on April 27, 1976. It has since become known in sphecidological circles as the Big Blue Book or simply B 3.

The years spent working with Dick, first as a student and later as a colleague, provide me with many happy memories. Dick is a remarkable guy and I especially treasure the friendship that we share.

R. M. Bohart: Recollections 1964–1973

E. E. Grissell[6]

My association with Dick Bohart began in the summer of 1964. As a soon-to-be undergraduate at Davis, I had an invitation to visit the entomology department and to "get acquainted." Dick fortunately happened to be chairman at the time, and he gave me both a warm welcome and a personal tour of the facilities. This was my first exposure to one of Dick's superior qualities . . . his love and enthusiasm for insects of all kinds. It is all pervasive, and he has retained this attitude for the 20 years I have known him. I'm certain it has been strongly felt by students and colleagues alike from the earliest days of his career.

My second meeting with Dick occurred only a few months later when school began. In retrospect the meeting was not quite as bad as it seemed at the time, but it was slightly different than I expected. The enthusiasm was still there to be certain, but Dick didn't seem to remember who I was . . . he couldn't remember my name. This bruised a rather young and fragile ego, but I soon learned a very simple fact about Dick . . . he can't remember anyone's name! For many years I

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have suspected that the first thing he does in the morning, upon arising, is to memorize the name on his driver's license so he might get at least one name correct during the day. It has been secretly amusing, over the years, to see how Dick manages to avoid the problem of introductions when the situation arises. Most of his colleagues are understanding sorts, though, and they often begin a conversation with their own name just to avoid possible confusion.

I was extremely fortunate, as a financially depauperate undergraduate, to receive Dick's early help in the form of a work-study position. Whether this opportunity was decreed by destiny, divinity, or deviousness I know not. I only know that help always came at the right time during my association with Dick and that the experience of working for him was an education, not a job. In looking back, even as a beginning student, my experiences with Dick have always been of a mutually beneficial nature: each person gaining in some way from the association. Doc has had this arrangement with many students, and most of us have recognized the benefits we've received. The fact is, that many of us have been dragged (albeit screaming and kicking) through our first publication largely on Dick's coat tails. We simply learned by doing. Perhaps more importantly though, some of us have learned the lesson exemplified by such generosity of time, knowledge, and experience. In matters of research and publication, Doc always gave credit where it was due, and usually gave a little extra for good measure.

During the mid 60's and early 70's, Dick had a profusion of graduate students working on taxonomic projects: Steve Buckett was working on noctuids, Mike Gardner on millipeds, Charles Dailey on cynipids, Don Horning on chrysidids, and I worked on chalcidoids. An "adopted" student, Dug Miller, worked on mealybugs. Doc even had several students, David Levin, Dick Brumley, Edmundo Rubio, and Joanne Slansky Wasbauer, who actually worked on sphecids. It is to Dick's credit that he gave each student the freedom to choose his or her own project. He was equally as willing to suggest any number of potential projects as well. Doc gave us the opportunity to work at our own pace which encouraged a necessary amount of self-reliance and responsibility. Conversely, however, Doc's door was always open and he would stop his own work at a moment's notice to answer questions or give help if he could. Occasionally there would be a flurry of pointed questions about "progress," intended, I'm certain, to gently prod some of the slower members of his entourage. Dick took an interest in each of his students and tried to accommodate the individual idiosyncrasies which characterize most taxonomists.

For several years (1968–1971) I worked as Dick's research and teaching assistant. This, again, was an education not only in taxonomy, but also in human behavior. Under his guidance I learned to catalog, collect and identify Hymenoptera, organize data, and write papers. At least I hope I learned. I also learned how to translate what Dick "said" into what he actually "wanted." This was purely a matter of survival. In the beginning it was my reaction to immediately do something if Dick asked me to. I soon learned, however, from his previous assistant, to put off until tomorrow whatever today's request might be. That way Dick might have a few days to sort of "rearrange" his thoughts, as it were. And it seemed as if he were constantly rearranging, much to the irritation of his taxonomy students. Now that Dick is safely retired I can reveal the secret "code" by which we assistants all lived. Doc was known to have his way of doing things, and there seemed, to the uninitiated, to be a rather stubborn streak to his nature. Those of us who lived by the code, however, knew that if Doc were "hit-up" with a new idea during his "rearranging phase," it often became incorporated into his thoughts and could be prodded forth several days later as a worthwhile revelation. It was *his* idea, of course, but that was actually a fair price to pay for getting things done *our* way. Graduate students aren't entirely stupid, you know!

The term paper in the undergraduate taxonomy course was a good example of this phenomenon. It was universally acknowledged, even before a student took the course, that the paper was an evil of unspeakable vileness. Some of us actually enjoyed the paper, but most did not. As an assistant in the course for 3 years, I was the intermediary between students and professor. This position was not the least bit enviable, and the first year was, shall we say, a struggle ("It was hell," said a former assistant). While students at Berkeley were burning the library and protesting every social evil, students in the taxonomy class at Davis were revolting (to say the least) against writing descriptions and making distribution maps. Needless to say, the assistant took the majority of the heat. By the second year, however, by invoking "the code," we managed to persuade Doc to alter the method of presenting the term paper. This so unbalanced the students that before they could organize themselves to riot, the course was over. Whereupon Doc and I, to illustrate one of our finer attributes, immediately took off for the deserts to do some collecting. The ploy worked so well that we tried it again the third year, and as far as I know, Doc changed the paper every year thereafter. I was fortunate to learn the universal doctrine of teaching under Doc's supervision: always leave the students off-balance, it is best for everyone involved!

My fondest experiences with Dick are associated with the five-week summer field course (then Ent. 49) and our numerous collecting trips together. In Ent. 49 Dick charged up a frenzy of entomomania among the undergraduates. This was due in large part to genuine enthusiasm and a prodigious knowledge of insects. Mention of this has been made in the previous paper by Arnold Menke, and I can confirm the effects. Students were out day and night ravaging the countryside for just "one more family." One summer, we had a particularly knowledgeable group of students, several of whom specialized in various micro-faunas. The number of families in each student's collection grew dramatically as battles raged over where to find the smallest Diptera, Coleoptera, Lepidoptera, or Hymenoptera. I can't remember who had the biggest collection, but I do know who held the record for "most countryside terrorized by a single entomologist": Baldomero Villegas! With two sweep nets going at once, bandoliers of cyanide vials over each shoulder, and a gallon killing bottle under each arm, Baldo struck fear even in the heart of Dick. Doc was forced to restrain the "great destroyer" while the other students collected first. Then he would let Baldo loose, and there would be little reason to return to that particular collecting site for several years. I know that Dick secretely admired such enthusiasm in a student.

Shortly before I first took Ent. 49 in 1966, Dick had changed the course from solely making an insect collection to including an ecological or biological project. The project was designed to "encourage" students to look at living insects. Almost anything would do, and if we didn't have an idea, Doc would soon supply us with one. Doc suggested that another student (Steve Clement) and I conduct observations on the nesting habits of a little known wasp named *Euparagia scutellaris.*

These observations formed the basis for my first publication (in coauthorship with Clement). When asked if Dick would also like to be a coauthor, he characteristically declined on the pretext that he had had nothing to do with the paper. Unlike many professors, Doc didn't take credit for work he didn't do.

A few years after taking the course, I had the privilege (at least it seemed so at the time) of serving as the teaching assistant. I might say that having the responsibility for 14 students is not quite the same as being one of the students. Having survived three years as intermediary between Doc and students in the taxonomy course had helped a bit, but I was not quite prepared for the food strikes, pranks, and physical exhaustion which came with the summer students. Doc always took it in stride, and in spite of suffering from a severe vitamin deficiency, could outcollect and outlast any of us any day. However I always managed to outdo Dick in one respect: it had something to do with automobiles. As I vaguely recall, a single trip with Doc at the wheel taught one a certain respect for one's life. Whenever a trip was in the offing, 14 (of 14) students tried jamming themselves into my station wagon. I still have heel marks in the back of my head to prove it.

Entomology 49 was a rewarding entomological and social experience for many students . . . a chance to "live, breathe, and eat bugs" as Doc would say. It was undoubtedly the most concentrated dose of real-world entomology that a student could receive.

Field trips with Doc were a special experience, shall we say, especially as they required a one to one relationship. They also required a lot of driving, but I try not to think much about that. Doc introduced me to the California desert regions, early on. He took me on numerous trips to what appeared to be the most barren places imaginable. I soon came to appreciate Doc's ability to find insects in these spots, however, and I must confess that the deserts are still my favorite domain. At first it was Doc who had all the expertise in terms of how and where to collect, but after a few years I think I showed him a thing or two about chalcidoids. With a little practice, however, Doc was as proficient as I was, and he was again the master collector. This, I think, is one of Dick's secrets . . . he is always willing to learn new things about bugs. Collecting trips provided a chance for protracted conversations, discussions of taxonomy, progress reports on the dissertation, comparisons of collecting techniques, assorted braggings about the day's catch, and keeping up with departmental gossip. These trips were a superior educational experience not to be duplicated in any classroom. Over the years, Dick has supplemented many a student's classroom education with his numerous field trips.

Over the years, I've grown to appreciate Dick more and more as an entomologist in the finest sense of the word. There is probably no aspect of entomology which, if required, he could not master. He has worked upon a diversity of taxonomic groups and in a diversity of fields from toxicology and economic entomology to ethology, ecology, and taxonomy. I've also grown to realize that Doc always had the interests of his students at heart, and in this respect something must additionally be said about his wife of 45 years, Margaret. In the treatment of students it is somewhat difficult to know where Doc leaves off and Margaret begins. In many ways Margaret has been the unofficial overseer of student concerns, and I know she has contributed much to their welfare. How many of us have enjoyed the hospitality of the Bohart home over the years, both as students and long afterwards? I was especially touched by the kindness of Dick and Margaret who took me into their home for the last year of my graduate work. Such attitudes toward students are the rule with Margaret and Dick and that makes them the special people they are.

THE LAST GRAD-STUDENT YEARS, 1973–1983

Lynn Kimsey[7]

I first became acquainted with "Doc" Bohart as an undergraduate in his Insect Systematics class in 1973. By this time in his career he had earned a reputation as a tough instructor and because of this the students in systematics, both graduate and undergraduate, were terrified of him. Many GI's from Viet Nam were beginning to come through the entomology program in this period; several told me that even in the Army they had heard that Dr. R. M. Bohart ate undergraduates for breakfast. Despite the students' fears of Doc in systematics class, many of them went into systematics or fields of research requiring this kind of background because of his influence. Most students came away with an understanding of systematics, species distinctions, and interspecies variation that they could have gotten nowhere else.

After completing his systematics class I decided I would never go into Systematics as a field of study, and certainly never work on wasps. However, one year later Doc proved to be quite persuasive; we co-authored a revision of the sphecid genus *Mellinus,* and I began my career as a wasp systematist. I worked as a scientific illustrator for Doc for about 6 years, drawing everything from mosquito larvae to eumenid legs and sphecid genitalia. He was a demanding taskmaster, each drawing had to be accurately and neatly done. The quality of the illustrations I make today is largely due to his training.

In 1975 I entered graduate school and became his student in systematics. Although my thesis work was on orchid bees we began a series of cooperative papers on the Chrysididae with the nebulous goal of straightening out the family. The first was the marathon revision of the Western Hemisphere *Hedychridium.* Since I was only being paid as a research assistant for 6 months he decided that we had to complete this revision of 30+, mostly new species, during this period. We lived and breathed *Hedychridium* for 6 months. That year I also was teaching assistant for his summer field course at Sage Hen Creek. Every hour not spent collecting (looking for specimens of *Hedychridium*) at Sagehen was spent looking at, writing about or drawing these wasps. Even now neither of us can look at *Hedychridium* without flinching.

While I was a graduate student the number of systematics students began to dwindle, primarily due to a growing lack of interest, even antagonism, toward systematics in the scientific community. Baldo Villegas, Norm Smith, Joanne Slansky (in absentia) and I were Doc's graduate students in 1975. In 1978 Joanne

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completed her thesis, Baldo took a job with the California Department of Agriculture, and Doc took on his last graduate student, Larry French, who is still under his guidance. In January, 1979, Doc retired from the University of California and became Professor Emeritus. Norm Smith and I finished our theses in 1980 and 1979, respectively.

The years I've known Doc have been years of change for him. Although considered stubborn by many, he is one of the most open-minded scientists about his field of study I have ever met. For example, Doc, in spite of years of disdain for certain new taxonomic approaches, finally adopted the use of cladograms in his papers to demonstrate relationships between genera and higher categories. In a lesser vein he now even uses a point punch to make points for mounting small specimens. [This is one change that is difficult to believe! Editors.] As Doc neared retirement he became more easy going and relaxed, and his students gradually lost their fear of him although the awe remained. In short, he became a pussycat.

Some things never seem to change, however. Even at the last Sage Hen class he taught (1979), his attitudes toward milk, buttermilk, peanut butter and jam sandwiches, Special K, and EXTRA dry martinis (double, of course) remained unchanged. The same could be said for his infamous Sunday dinner at Sage Hen—wine punch, concocted of lemon-lime soda and $2 a gallon red wine. This tradition continued despite surreptitious additions of absolute ethanol to the punch by a variety of students.

Since retiring, Doc still comes in to work practically every day or works at home on Chrysididae and Sphecidae. We're still pursuing the nebulous goal of revising the family Chrysididae and have continued to do cooperative papers on this group.

R. M. Bohart's Impact on the U.C. Davis Insect Collection

R. O. Schuster[8]

In 1946 the Entomology Department made a commitment to establish a research collection by hiring A. T. McClay to curate what had been mainly a teaching oriented collection. Mr. McClay brought to the department a fine personal collection of Coleoptera, and Dick contributed research material in the Diptera, Hymenoptera, and Strepsiptera. Dick's interests eventually polarized with the aculeate wasps, and the collection has grown in this area to be among the most comprehensive in the world.

In 1950 Dick became involved with Entomology 49 (now 109), a summer field course stressing the biology, collecting techniques, and taxonomy of insects. Later, he taught the course for both the U.C. Berkeley and Davis campuses. He provided financial assistance for the development of the University Sage Hen Creek Field

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Station near Truckee, California, and for many years the Entomology 109 course has been conducted exclusively from Sage Hen. The insect fauna of the Sage Hen area is extremely well known as a result of repeated and intensive collecting, and the specimens collected by Dick, along with those of numerous students, are deposited in the department's collection. Throughout the years, specimens collected by Dick's undergraduate and graduate students have contributed significantly to the development of the collection at Davis.

Field work in support of his research took him frequently, usually with coworkers or students, to desert areas of the western United States. Expeditions to Africa and South America were made in 1972 and 1975–1976, Venezuela in 1973, and Australia in 1979. Margaret Bohart has been a frequent collecting companion on these trips, and is a proficient collector. The resulting specimens have been carefully taken, meticulously prepared, and of exceptional scientific value.

In addition to the specimens that have directly or indirectly resulted from Dick's research and teaching, he also has provided generous personal financial support which has assisted in the collection's becoming a major resource for systematic entomology.

R. M. Bohart—an Overview

E. E. Grissell and A. S. Menke

During the past two years we have had occasion to contact many former students, colleagues, and friends of Dick Bohart. Through hours of conversations, acres of correspondence, and pounds of manuscripts, we have come to learn that there is an unsuspected uniformity of opinion about Dick among his associates. We believe it is appropriate to present a short overview of the consensus which has crystalized as we have put this "Festschrift" together.

One of the main points of agreement among Dick's associates has been his generosity toward students, friends, and colleagues. On the strictly practical side this generosity has been expressed in the form of untold thousands of identifications which Dick has given over many years to nearly anyone who has asked for them. More than one curator has told us that they slip "extra" specimens into a shipment which Dick has requested and that these additional specimens always come back identified. The material is always identified in a quick, conscientious manner whether it is a group he is currently working upon, or a group of some past interest. The names are provided, in many cases, at the loss of personal research time as well as a great amount of labor which often extends late into the night at home. It is a labor of love, of course, and its breadth of coverage will likely not be seen again in this day of specialization. He is among the last of those "all knowledgeable" entomologists who can identify countless species in a wide range of families.

Perhaps more important than the obvious public service that Dick has provided over the past 50 years is the generosity of time which he has extended to students.

Dick has always been available for questions, even at the expense of his own work. Not only did he give us the feeling that our work was important (little did we know!), but he exemplified what all of us should represent as taxonomists. Perhaps Norm Smith, one of Dick's later students, summed it up best when he wrote to us:

> "I think one thing that I respected most about Doc was that he was an excellent example of what a University Professor should be. A young, impressionable Ph.D. student could find no finer example to emulate. In academia, Doc practiced what he preached and was able to set himself as a prime example of what could be accomplished with dedication and perseverance in one's field of endeavor."

Doc's generosity to students has taken a variety of forms, from subsidizing field trips at personal expense to helping with employment. But many students remember him most as the motivating force behind their first publication. Many of us have been junior authors with Dick, and it is safe to say, we think, that we may not always have contributed our "fair" share toward the paper. On the other hand, where other professors might insist on being a co-author on a student's dissertation, Dick would never consider it.

In co-authoring a paper, Dick was a considerable taskmaster, but at the same time he was willing to listen to the other person's point of view and to compromise. Dick also read and reviewed a student's paper with care and concern for the future of that student. Roy Snelling wrote the following about the help that Dick gave him as an early student:

> "Always, he was remarkably patient and helpful to me, answering my naive questions, identifying specimens, sending reprints, etc. He also had the no doubt painful task of reading my first paper on *Polistes* systematics (I was then a junior in high school). With admirable restraint and kindness, Dick suggested I might profit from holding the paper a while until I had accumulated more data on certain of the forms; the paper has long since disappeared into gracious oblivion."

Dick is continuing his work, of course, with projects on Sphecidae and Chrysididae, but he is no longer taking graduate students. However, Dick's former students indirectly continue his work and have achieved some notoriety of their own. Among these may be included the Chief of the USDA's Systematic Entomology Laboratory and 3 Research Entomologists with the same organization; the Chief of the USDA's Bee Biology and Systematics Laboratory, Logan, Utah; the Supervisory Research Entomologist of the Division of Vector-Borne Viral Diseases, Ft. Collins, Colorado; the former Dean of the College of Agriculture, Universidad de Zulia, Maricaibo, Venezuela; the former chairman of the Department of Entomology, University of California, Riverside; professors and assistant professors in various universities throughout the country, and several entomologists in state agricultural departments.

Everyone we've contacted has commented upon Dick's remarkably broad interest in insects . . . an interest that has spanned more than 60 years. Although recognized largely for his work with numerous groups of aculeate Hymenoptera, Dick has also published papers on Thysanoptera, Lepidoptera, Diptera, Homoptera, Strepsiptera, and even Isopoda! His work has ranged from the toxicological to the taxonomical. A glimpse through the appended bibliography will quickly attest to Dick's diversity as an entomologist. One notes several books or book length treatises in several different groups of insects. Over the years his knowledge and scientific stature in taxonomy have prompted many authors to name new species and genera in his honor. He even has a family, Bohartillidae Kinzelbach (Strepsiptera), named after him.

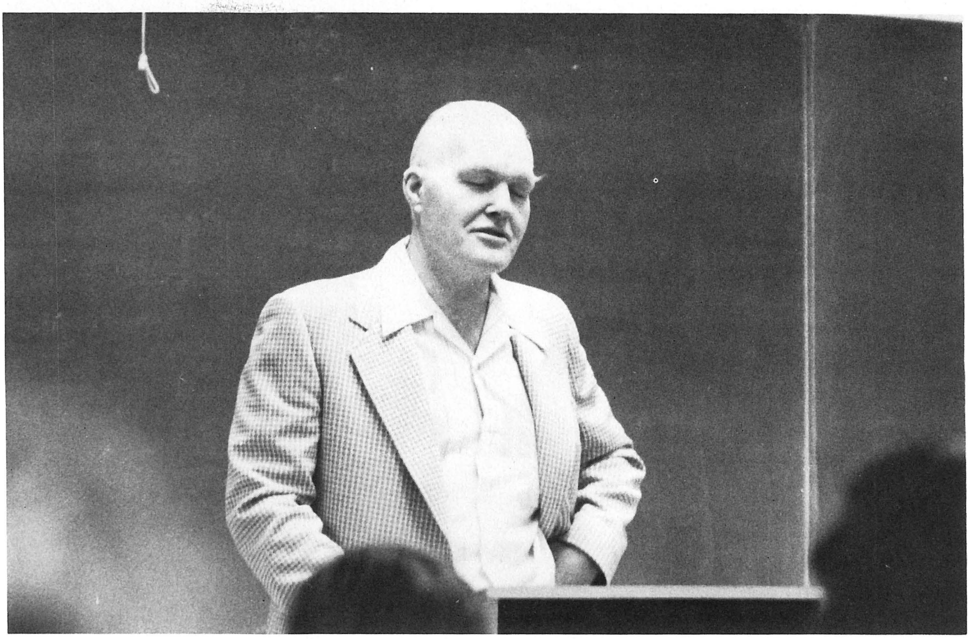
Perhaps less well known is the role that Dick has played in building the University of California insect collection at Davis. This collection was in a fledgling state in the late 40's, and Dick, along with the help of A. T. McClay, its first curator, and R. O. Schuster, its present curator, played a leading role in building and developing the collection, often subsidizing its growth with personal funds. Dick has always been a keen collector and a meticulous curator, and material placed in the collection is of the highest quality. Today, the insect museum at Davis is one of the outstanding university collections in the country.

As an aside from Dick's career, few who have come into contact with him have failed to note his rather acute sense of humor. A personal anecdote, concerning long-known or "old-time" taxonomists, is a special pleasure coming from Dick. We have also all fallen victim to the unexpected pun which could erupt at any time or place. Better than trying to explain all of this we have been very fortunate in obtaining a series of photos taken by Bob Kimsey during one of Dick's taxonomy classes in 1979. We think that Bob has done a remarkable job of capturing his expressions and moods which most of us remember as students. The accompanying captions are doubly amusing when one considers that Dick wrote them himself. Little did he know these photos would ever be made public, but how very well he knows what his students are thinking!

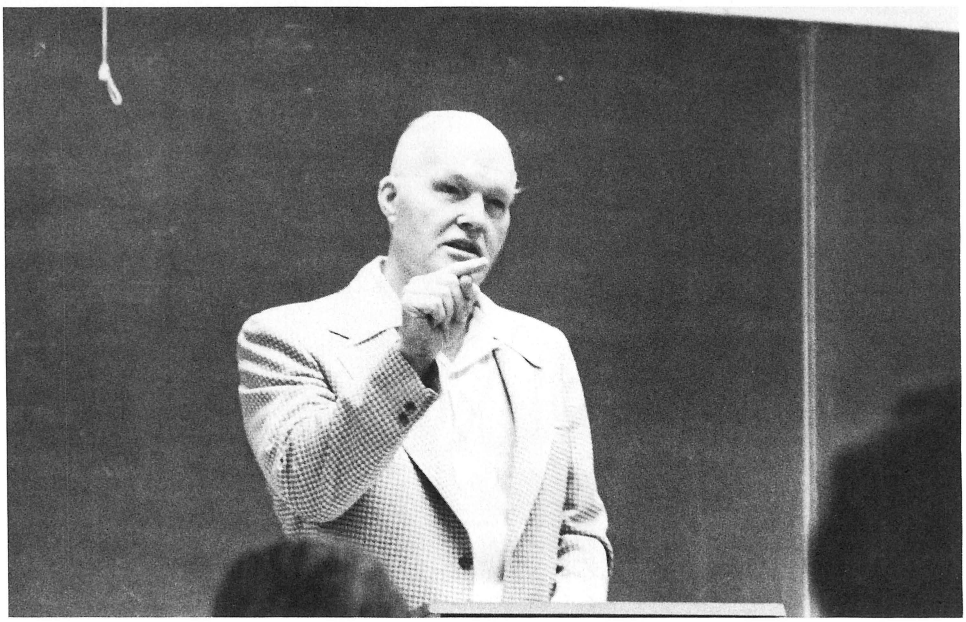
We think anyone who knows Dick will agree that over his long and varied career one of his finest assets has been Margaret, his wife. In fact we suspect that many of Dick's finer qualities have been encouraged and nurtured by Margaret. Perhaps she has added just the right touch of "reason" to balance out Dick's somewhat over-zealous nature. Not to detract from Dick, but we can attest to rather severe working conditions upon occasion; conditions which were mercifully interrupted by coffee and cake, or a freshly baked pie upon the insistence of Margaret. While Dick watched over our minds, Margaret often took care of our nutritional needs and made certain Dick didn't treat us too severely. She also offered Dick's friends, colleagues, students, and visitors the hospitality of her home. We suspect that by taking exceptionally good care of Dick over these many years, that Margaret has contributed more than her fair share to Dick's accomplishments. We know that she is a very capable collector in her own right. We also know that Margaret was the precursor of the photocopying machine and that for many years she "duplicated" all of Dick's necessary research references on a typewriter. Such duty goes a bit beyond normal marital laws, we feel. Perhaps less well known is Margaret's role as a guide during many of Dick's collecting trips. It is a well kept secret that Dick cannot tell left from right, especially while driving. Margaret has been, on many occasions, the only means by which Dick has been able to return home with any certainty. We all recognize that Dick would not be the person he is without Margaret.

Of all that has been said of Dick Bohart, perhaps the simplist and most obvious

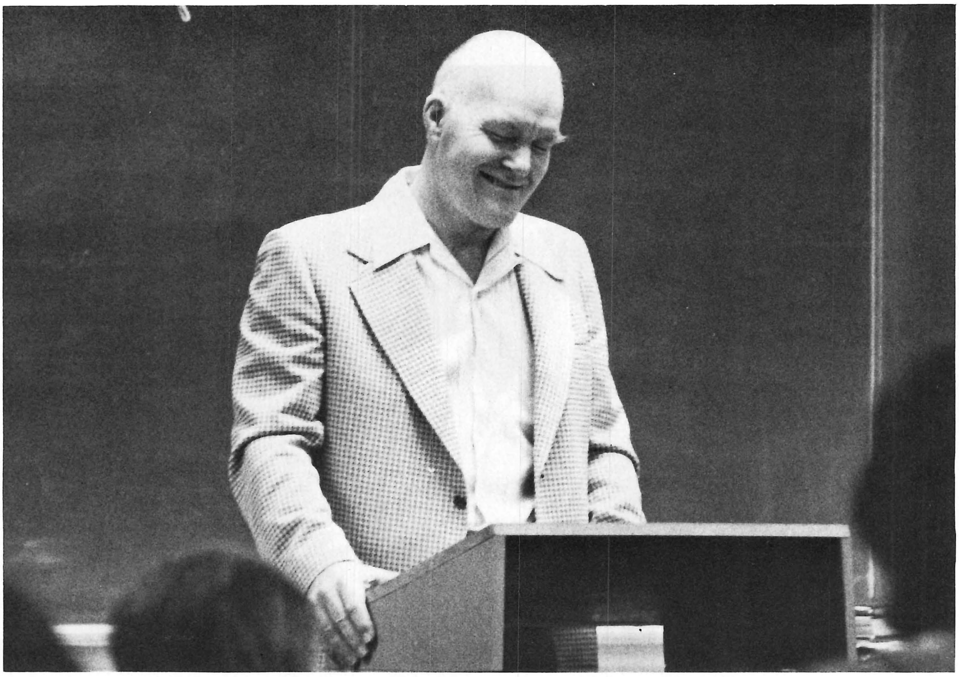
"THERE IS LITTLE BIT OF HAM IN EVERY PROFESSOR—SOME MORE THAN OTHERS"



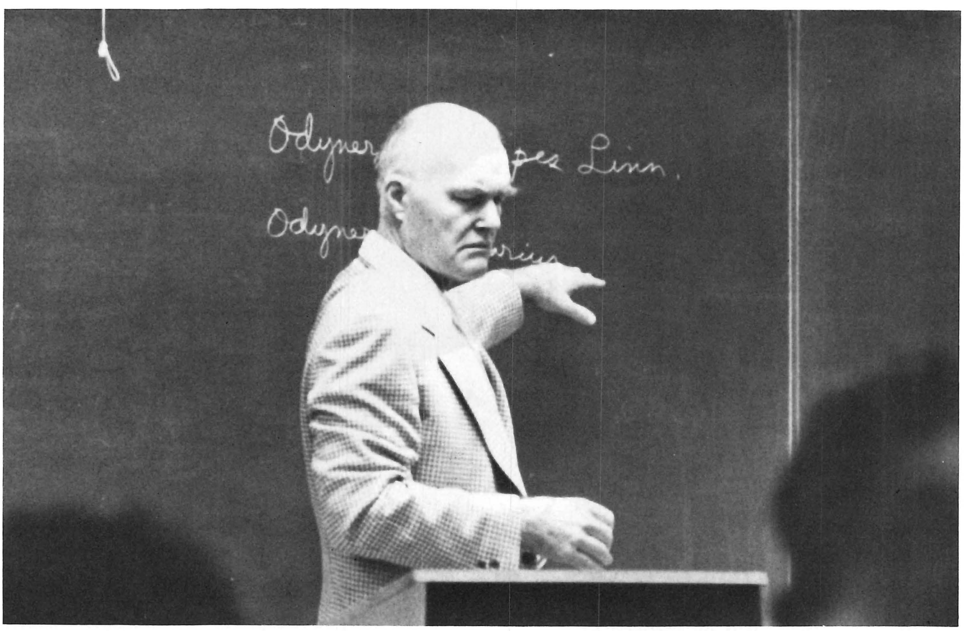
"You may as well resign yourselves, we are both stuck here for an hour"



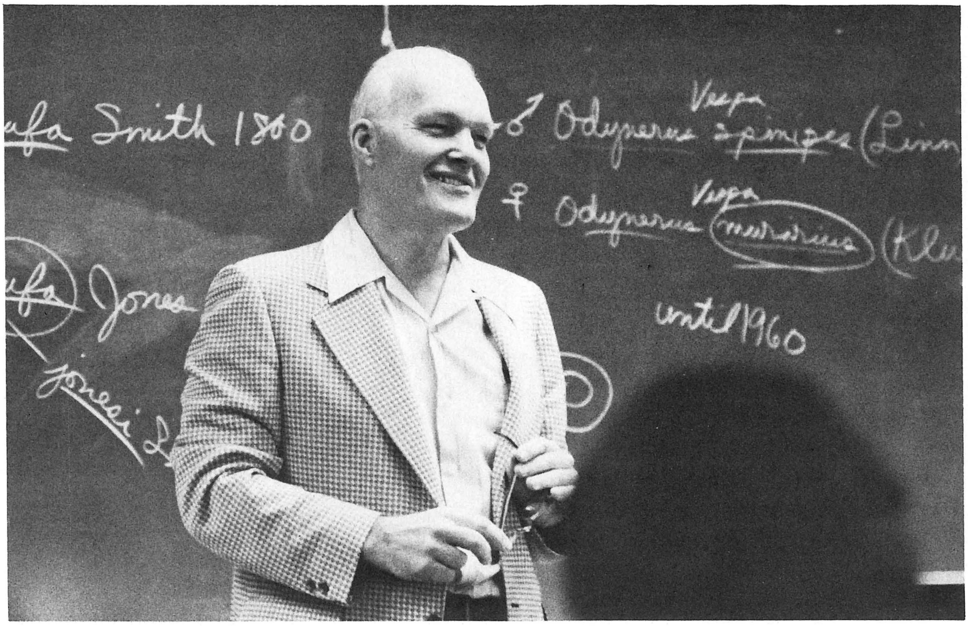
"Pay close attention, or else!"



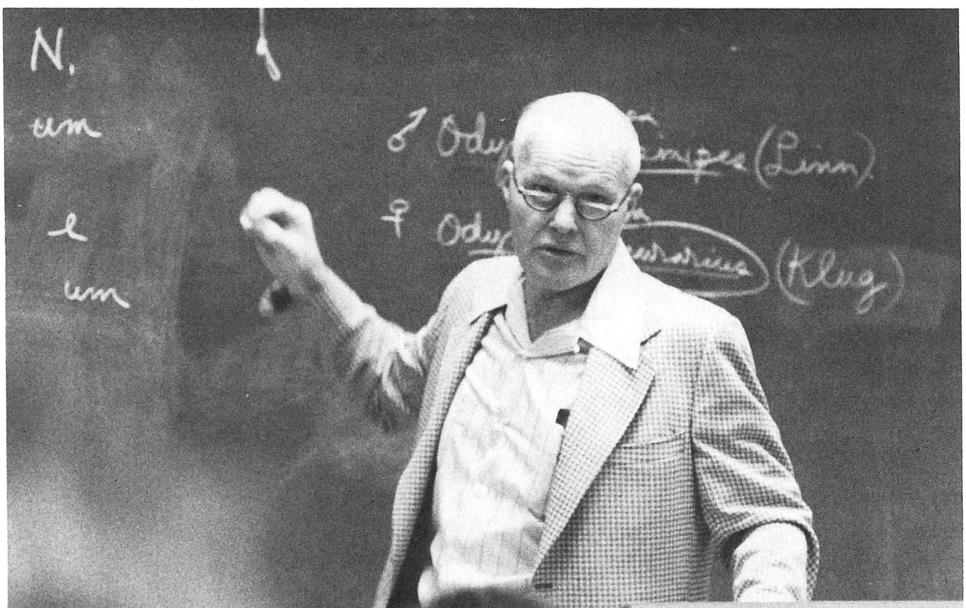
Look out! He's coming up with something!



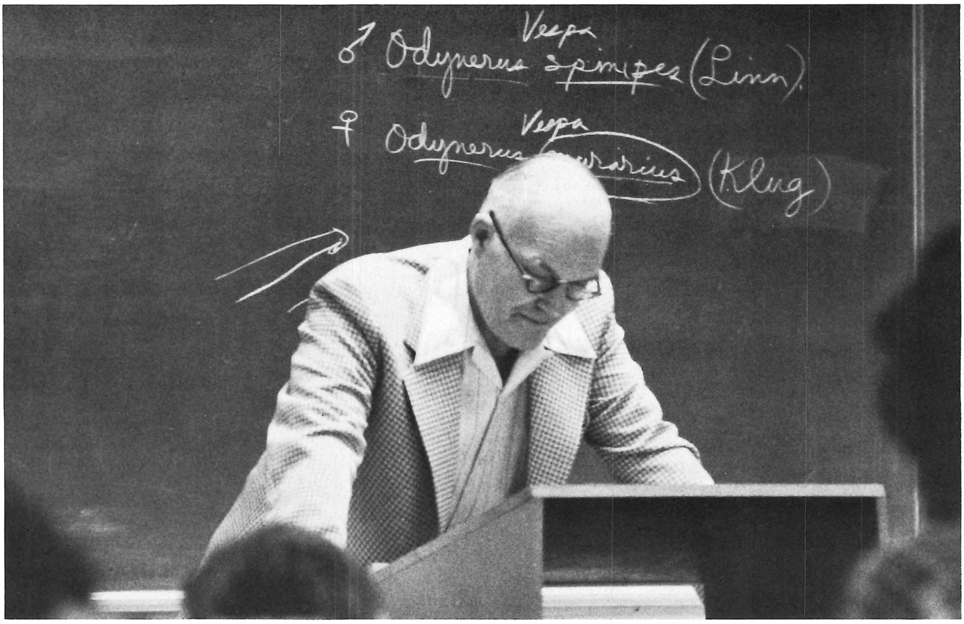
"This is really gruesome stuff"



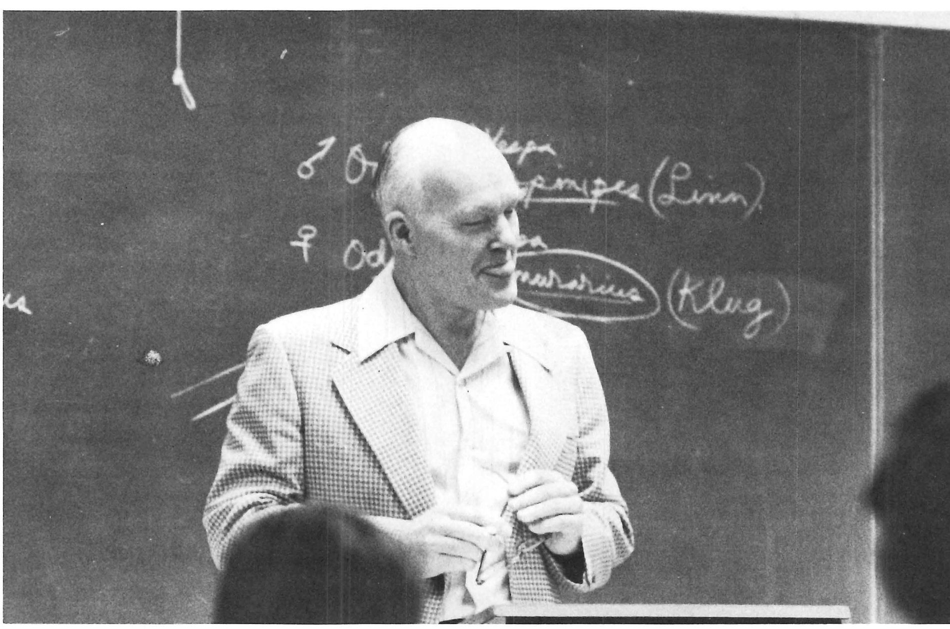
"You can't believe what those old systematists did!"



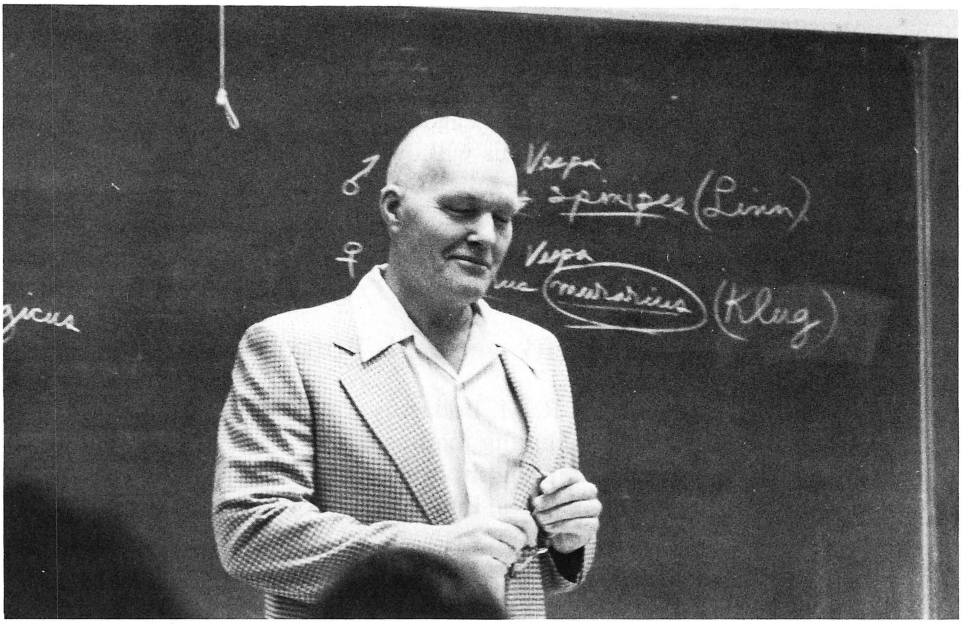
"I am absolutely serious about this!"



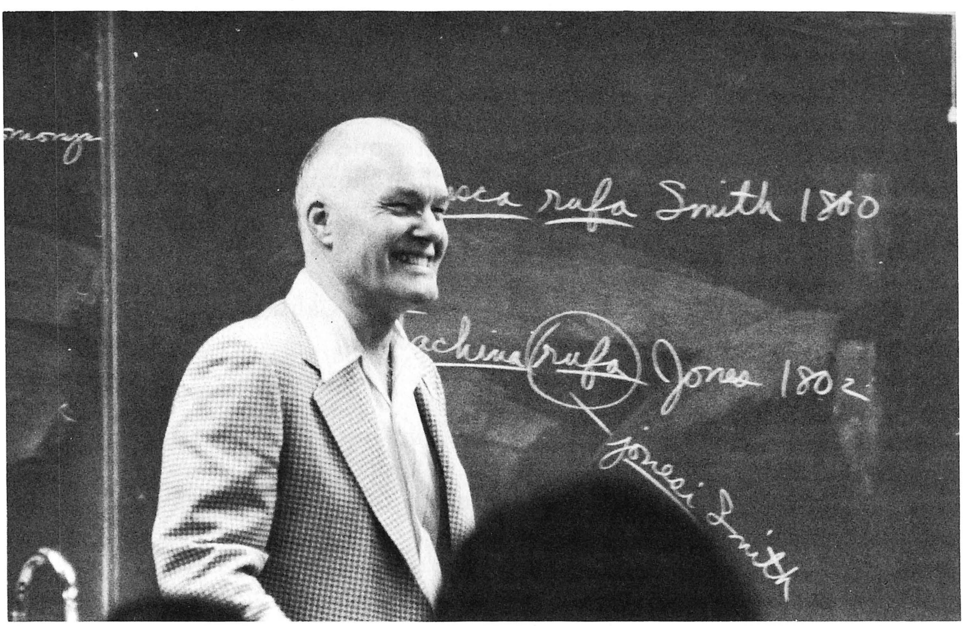
"This nomenclature stuff takes close concentration"



"My opinion of numerical taxonomy is hard to express in words"



"I have a little story to tell you"



"I enjoyed the punch line too!"

conclusion is that he has an overwhelming and truly enthusiastic love of insects. There is a realization among his friends that over the years, Dick's enthusiasm for insects, if anything, has grown stronger. We also know that this enthusiasm has infected each of his students and colleagues in some manner and that we are all the better for it. Not that many of us will duplicate Dick's remarkably broad knowledge, nor his zest for life . . . for that is not taught. It is simply admired and respected.

Bibliography of R. M. Bohart

The following list of papers by R. M. Bohart is complete through 1982. In an effort to give correct citations, including mailing dates, we personally examined nearly all of his publications. Some of his more obscure mosquito papers published during WW II were found in the Medical Entomology Project at the U.S. National Museum. Other papers were checked in the National Agriculture Library and the library of the Smithsonian Institution. Lynn Kimsey checked a few obscure papers for us, and also provided us with a copy of Dick's list of publications. Papers not seen by us are preceded by an asterisk. When known, the true date of publication, that is, the mailing date, is cited at the end of each entry. Often this has meant some sleuthing in journals. If a precise date could not be determined we have simply indicated the month of issue in quotation marks at the end of the entry. Circumstantial evidence suggests that some of Dick's papers published in the December issues of the *Journal of Economic Entomology* may not have appeared until early the following year.

We found several papers that Dick had overlooked when his list was made up. Also, some papers were out of chronological sequence in his list. The result is that the number we assign each paper in the following bibliography does not necessarily coincide with those stamped on his reprints.

1936

1. A preliminary study of the genus *Stylops* in Calif. (Part I) (Strepsiptera, Stylopidae). Pan-Pac. Ent. 12:9–18. March 20.

1937

2. A preliminary study of the genus *Stylops* in Calif. (Part II) (Strepsiptera, Stylopidae). Pan-Pac. Ent. 13:49–57. "April."
3. A new genus and species of Strepsiptera from Canada. Pan-Pac. Ent. 13: 101–105. "July."
4. Synonymy of the genus *Pseudoxenos* Saunders (Strepsiptera, Xenidae) and records of stylopized Hymenoptera from North Carolina. Psyche 44:132–137. "December."

1938

5. A synopsis of the genus *Euparagia* (Hymenoptera, Vespidae, Euparagiinae). Pan-Pac. Ent. 14:136–139. August 19.

*6. Flower thrips in southern California on ornamentals. Floral West 4:4.

1939

7. Taxonomy of the typical subgenus *Odynerus* in North America (Hymenoptera: Vesidae [sic]). Pan-Pac. Ent. 15:76–84. April 27.
8. Notes on *Odynerus* with a key to the North American subgenera and description of a new subgenus (Hymenoptera, Vespidae). Pan-Pac. Ent. 15: 97–104. August 9.
9. A synopsis of the *Odynerus boscii* group in North America (Hymenoptera, Vespidae). Bull. Brooklyn Ent. Soc. 34:245–251. November 13.
10. A new host plant and locality record for the Christmas berry thrips. J. Econ. Ent. 32:880–881. "December."

1940

11. A revision of the North American species of *Pterocheilus* and notes on related genera (Hymenoptera, Vespidae). Ann. Ent. Soc. Amer. 33:162–208. "March."
12. A preliminary study of the subgenus *Leptochilus* in North America (Hymenoptera: Vespidae). Pan-Pac. Ent. 16:81–91. May 23.
13. Additional notes on *Pterocheilus diversicolor* Rohwer (Hymenoptera: Vespidae). Ann. Ent. Soc. Amer. 33:282. "June."
14. Studies on the biology and control of sod webworms in California. J. Econ. Ent. 33:886–890. "December."

1941

15. Yellowjackets versus campers. Pan-Pac. Ent. 17:58. May 15.
16. A revision of the Strepsiptera with special reference to the species of North America. Univ. Calif. Publ. Ent. 7:91–160. August 27.

1942

17. Life history of *Diaspis boisduvalii* and its control on *Cattleya* with calcium cyanide. J. Econ. Ent. 35:365–368. "June."
18. *Platynota stultana* as a pest of field-grown carnations. J. Econ. Ent. 35:399–403. "June."
19. R. M. Bohart and A. Mallis. The control of pillbugs and sowbugs. J. Econ. Ent. 35:654–658. "October."
20. An analysis of the *Odynerus congressus* group of the subgenus *Leptochilus* (Hymenoptera, Vespidae). Pan-Pac. Ent. 18:145–154. October 31.

1943

21. North American *Stenodynerus* of the *anormis* group (Vespidae: Hymenoptera). Bull. Brooklyn Ent. Soc. 38:6–11. March 31.
22. A new generic name in Strepsiptera and description of a new species (Strepsiptera, Stylopidae). Bull. Brooklyn Ent. Soc. 38:12–13. March 31.
23. Calcium cyanide fumigation for the western thrips. J. Econ. Ent. 36:442–444. "June."
24. New species of *Halictophagus* with a key to the genus in North America (Strepsiptera, Halictophagidae). Ann. Ent. Soc. Amer. 36:341–359. October 4.
25. Bohart, G. E., P. C. Ting, R. M. Bohart, and C. K. Dorsey. Fundamentals

of field malariology and mosquito control—A reference and teaching syllabus. U.S. Naval Construction Training Center, Medical Dept., Camp Peary [sic], Williamsburg, Va., 37 pp.

1944

26. *Stenodynerus fundatus* and related species in North America (Hymenoptera, Vespidae). Pan-Pac. Ent. 20:69–75. April 29.
27. K. L. Knight, R. M. Bohart, and G. E. Bohart. Keys to the mosquitoes of the Australasian Region. Natl. Research Council, Div. Med. Sci., Off. Med. Inform., Washington, D.C., 71 pp. "July."
28. R. M. Bohart and D. S. Farner. New culicine mosquitoes from the Philippine Islands (Diptera, Culicidae). Proc. Biol. Soc. Wash. 57:69–73. October 31.
29. A. Stone and R. M. Bohart. Studies on mosquitoes from the Philippine Islands and Australasia (Diptera: Culicidae). Proc. Ent. Soc. Wash. 46:205–225. November 21.
30. D. S. Farner and R. M. Bohart. Three new species of Australasian *Aedes.* Proc. Biol. Soc. Wash. 57:117–122. November 30.

1945

31. D. S. Farner and R. M. Bohart. A preliminary revision of the *Scutellaris* group of the genus *Aedes.* U.S. Nav. Med. Bull. 44:37–53. "January."
32. A synopsis of the Philippine mosquitoes. Bur. Med. and Surg., Navy Dept., Washington, D.C. Navmed 580:1–88. January.
33. A preliminary synopsis of the mosquitoes of Okinawa. U.S. Naval Med. Res. Unit #2, Med. Sect. IsCom, Okinawa, 16 pp.

*34. Notes of disease-bearing mosquitoes in four specific areas: (a) Formosa; (b) China coast from Amoy to Shanghai; (c) Ryukyu Islands (d) Bonin Islands. Malaria and Epidemic Disease Control Bulletin #3, pp. 2–4.

35. New species and subspecies of *Rygchium* for North America (Hymenoptera: Vespidae). Proc. Ent. Soc. Wash. 47:45–49. March 2.
36. H. S. Hurlbut and R. M. Bohart. Factors affecting the larvicidal action of DDT on *Culex quinquefasciatus.* J. Econ. Ent. 38:725. "December."

1946

37. A key to the Chinese culicine mosquitoes. Bur. Med. and Surg., Navy Dept., Washington, D.C. Navmed 961:1–23. "January."
38. R. M. Bohart and R. L. Ingram. Four new species of mosquitoes from Okinawa (Diptera: Culicidae). J. Wash. Acad. Sci. 36:46–52. February 15.
39. New species of mosquitoes from the Marianas and Okinawa (Diptera, Culicidae). Proc. Biol. Soc. Wash. 59:39–46. March 11.
40. Common caterpillars of the flower garden and their control. Southern Calif. Homes and Gardens 3(6):7, 22.
41. Tsai-Yu Hsiao and R. M. Bohart. The mosquitoes of Japan and their medical importance. Bur. Med. and Surg., Navy Dept., Washington, D.C. Navmed 1095:1–44. September.
42. R. M. Bohart and R. L. Ingram. Mosquitoes of Okinawa and islands in the Central Pacific. Bur. Med. and Surg., Navy Dept., Washington, D.C. Navmed 1055:1–110. October.

43. A new species of *Halictophagus* parasitic on Cercopidae (Strepsiptera, Halictophagidae). Proc. Ent. Soc. Wash. 48:200–202. November 1.
44. B. V. Travis and R. M. Bohart. DDT to control maggots in latrines. J. Econ. Ent. 39:740–742. "December."

1947

45. Sod webworms and other lawn pests in California. Hilgardia 17:267–308. "March."
*46. Book review: Biologie des Abeilles, by Maurice Caullery, et al. Quart. Rev. Biol. 22:222. "September."
*47. Strepsiptera—An insect oddity. Ward's Nat. Sci. Bull. 21:28–29. "November."

1948

48. Contributions toward a knowledge of the insect fauna of Lower California, No. 9, Hymenoptera: Eumeninae. Proc. Calif. Acad. Sci. (4) 24:313–336. "March."
49. Organic phosphate insecticides: Mosquito larvae. Calif. Agric. 2(4):22–23. "April."
50. New North American *Rygchium* (Hymenoptera, Vespidae). Bull. Brooklyn Ent. Soc. 43:80–87. July 1.
51. The genus *Euparagia* in North America (Hymenoptera: Vespidae). Pan-Pac. Ent. 24:149–154. October 16.
52. The red *Stenodynerus* of Florida (Hymenoptera: Vespidae). Florida Ent. 31: 71–80. November 6.
53. A comparison of DDT and Dichlorodiphenyl Dichlorethane as larvicides for *Aedes* mosquitoes. J. Econ. Ent. 41:834–835. "October."
54. Differentiation of larvae and pupae of *Aedes dorsalis* and *Aedes squamiger* (Diptera, Culicidae). Proc. Ent. Soc. Wash. 50:216–218. November 30.

1949

55. The subgenus *Neoculex* in America north of Mexico (Diptera, Culicidae). Ann. Ent. Soc. Amer. 41:330–345. January 27 (incorrectly 1948).
56. Notes on North American *Polistes* with descriptions of new species and subspecies (Hymenoptera, Vespidae). Pan-Pac. Ent. 25:97–103. July 29.
57. The genus *Stenodynerus* in southern Arizona (Hymenoptera, Vespidae). Proc. Ent. Soc. Wash. 51:237–259. December 29.

1950

58. A synopsis of *Maricopodynerus* (Hymenoptera: Vespidae). Bull. Brooklyn Ent. Soc. 45:17–25. February 18.
59. New species of solitary Vespidae from North America (Hymenoptera, Vespidae). Proc. Biol. Soc. Wash. 63:77–81. May 25.
60. R. M. Bohart and W. D. Murray. DDT resistance in *Aedes nigromaculis* larvae. Proc. Papers 18th Ann. Conf. Calif. Mosq. Contr. Assoc., pp. 20–22. "August."
61. Observations on snow mosquitoes in California (Diptera: Culicidae). Pan-Pac. Ent. 26:111–118. September 27.

*62. Turf pests. Northern Calif. Turf. Conf. Rept., pp. 28–31. "November."
63. A new species of *Orthopodomyia* from California (Diptera, Culicidae). Ann. Ent. Soc. Amer. 43:399–404. November 17.
64. North American additions to the genus *Pterocheilus* (Hymenoptera, Vespidae). Proc. Biol. Soc. Wash. 63:195–200. December 29.

1951

65. Family Sapygidae, pp. 777–778. *In:* C. F. W. Muesebeck et al., Hymenoptera of America north of Mexico. Synoptic catalog. U.S. Dept. Agric. Monograph 2. July 11.
66. Family Vespidae, pp. 875–907. *In:* C. F. W. Muesebeck et al., Hymenoptera of America north of Mexico. Synoptic catalog. U.S. Dept. Agric. Monograph 2. July 11.
67. The Myrmecolacidae of the Philippines (Strepsiptera). Wasmann J. Biol. 9: 83–103. May 25.
68. S. B. Freeborn and R. M. Bohart. The mosquitoes of California. Bull. Calif. Insect Survey 1:25–78. June 8.

1952

69. The California species of mite-bearing *Stenodynerus* (Hymenoptera, Vespidae). Proc. Ent. Soc. Wash. 54:38–53. February 15.

1953

70. S. F. Bailey and R. M. Bohart. A mosquito survey and control program in Guam. J. Econ. Ent. 45:947–952. February 9 (incorrectly 1952).
71. A new species of *Culex* and notes on other species of mosquitoes from Okinawa (Diptera, Culicidae). Proc. Ent. Soc. Wash. 55:183–188. August 24.
72. R. M. Bohart, E. C. Mezger, and A. D. Telford. Observations on the seasonal history of *Aedes squamiger*. Proc. Papers 21st Ann. Conf. Calif. Mosq. Contr. Assoc., pp. 7–9. "November."
73. Three new species of *Stenodynerus* from eastern United States (Hymenoptera, Vespidae). Proc. Biol. Soc. Wash. 66:185–189. December 2.

1954

74. Cherry fruit sawfly. Calif. Agric. 8(3):14. "March."
75. Identification of first stage larvae of California *Aedes* (Diptera, Culicidae). Ann. Ent. Soc. Amer. 47:355–366. August 17.
76. Some peculiarities in the distribution of mosquitoes in California. Proc. Papers 22nd Ann. Conf. Calif. Mosq. Contr. Assoc., pp. 18–19. "July."
77. S. F. Bailey, R. M. Bohart, and L. J. Booher. Mosquito control on the farm. Calif. Agric. Exp. Sta. Circ. 439, 27 pp. "August."

1955

78. Book review: Insects of Micronesia, vol. I, by J. Linsley Gressitt. Pan-Pac. Ent. 31:172. December 13.
79. Strepsiptera, pp. 566–569. *In:* "A century of progress in the natural sciences, 1853–1953." California Academy of Sciences, San Francisco. "November."

80. The role of taxonomy in relation to ecology and control. Proc. Papers 23rd Ann. Conf. Calif. Mosq. Contr. Assoc. and 11th Ann. Meeting Amer. Mosq. Contr. Assoc., pp. 97–98. "December."
81. North American *Leptochilus* of the *trinodus* group (Hymenoptera, Vespidae). Proc. Ent. Soc. Wash. 57:287–299. December 22.

1956

82. R. M. Bohart and A. H. Smith. Radioisotopes for evaluation of a fly nuisance source. Calif. Vector Views 3:5, 7. "February."
83. New species of mosquitoes from the southern Ryukyu Islands. Bull. Brooklyn Ent. Soc. 51:29–34. May 11.
84. R. M. Bohart and E. I. Schlinger. Descriptions of two new western *Oxybelus* (Hymenoptera: Sphecidae). Proc. Biol. Soc. Wash. 69:37–39. May 21.
85. A. H. Smith and R. M. Bohart. Evaluating fly nuisance source. Calif. Agric. 10(7):11–12. "July."
86. Identification and distribution of *Aedes melanimon* and *Aedes dorsalis* in California. Proc. Papers 24th Ann. Conf. Calif. Mosq. Contr. Assoc., pp. 81–83. July 30.
87. E. C. Loomis, R. M. Bohart, and J. N. Belkin. Additions to the taxonomy and distribution of California mosquitoes. Calif. Vector Views 3:37–45. "August."
88. R. M. Bohart and J. A. Powell. Observations on the nesting habits of *Eucerceris flavocincta* Cresson (Hymenoptera: Sphecidae). Pan-Pac. Ent. 32: 143–144. August 14.
89. R. M. Bohart and E. I. Schlinger. New species of *Oxybelus* from western North America (Hymenoptera: Sphecidae). Pan-Pac. Ent. 32:147–156. November 7.
90. R. M. Bohart and E. I. Schlinger. An annotated synonymical list of North American *Oxybelus* (Hymenoptera: Sphecidae). Pan-Pac. Ent. 32:157–165. November 7.

1957

91. Insects of Micronesia: Culicidae. Insects Micronesia 12:1–85. January 21 (incorrectly 1956).
92. R. M. Bohart and R. C. Bechtel. The social wasps of California (Vespinae, Polistinae, Polybiinae). Bull. Calif. Insect Survey 4:73–101. March 1.
*93. Five years of fly control on an agricultural university campus. Calif. Vector Views 4:23, 25, 26. "April."
94. R. M. Bohart and E. I. Schlinger. California wasps of the genus *Oxybelus* (Hymenoptera: Sphecidae, Crabroninae). Bull. Calif. Insect Survey 4:103–142. April 11.
95. Biological studies, mosquito control, and the entomologist. Proc. Papers 25th Ann. Conf. Calif. Mosq. Contr. Assoc., pp. 78–79. "July."
96. R. M. Bohart and R. K. Washino. Differentiation of second and third stage larvae of California *Culex* (Diptera: Culicidae). Ann. Ent. Soc. Amer. 50: 459–463. September 15.

1958

97. E. C. Loomis, R. M. Bohart, and J. N. Belkin. Insecticides for control of

flies on poultry ranches, dairies, homes, and food processing plants. Univ. Calif. Agric. Ext. Serv. (unnumbered bulletin), 10 pp. "June" [also printed in Calif. Vector Views 5:35–41 (June)].

98. A North American species of the genus *Prosopigastra* (Hymenoptera, Sphecidae). Proc. Ent. Soc. Wash. 60:122–124. "June."

99. R. M. Bohart and H. K. Court. New species of *Lindenius* from western North America (Hymenoptera: Sphecidae). Pan-Pac. Ent. 34:161–167. July 22.

100. A new *Priononyx* and a key to the North American species (Hymenoptera: Sphecidae). Bull. Brooklyn Ent. Soc. 53:90–93. October 15.

1959

101. New species of *Aphilanthops* from western North America (Hymenoptera, Sphecidae). Ann. Ent. Soc. Amer. 52:105–108. January 20.

102. R. M. Bohart, D. H. Ecke, J. Fowler, and other collaborators. *In:* E. C. Loomis, ed., A field guide to the common mosquitoes of California. Ent. Committee, Calif. Mosq. Contr. Assoc., 27 pp. "February."

103. A survey of the mosquitoes of the southern Ryukyus. Mosq. News 19:194–197. "September."

1960

104. R. M. Bohart and L. E. Campos. A review of the genus *Omalus* Panzer in North America (Hymenoptera, Chrysididae). Ann. Ent. Soc. Amer. 53:235–250. March 31.

105. Addendum to a review of the genus *Omalus* Panzer in North America (Hymenoptera, Chrysididae). Ann. Ent. Soc. Amer. 53:435. May 31.

106. R. M. Bohart and P. M. Marsh. Observations on the habits of *Oxybelus sericeum* Robertson. Pan-Pac. Ent. 36:115–118. August 9.

1961

107. R. M. Bohart and A. S. Menke. A review of the genus *Palmodes* in North America (Hymenoptera: Sphecidae). Proc. Ent. Soc. Wash. 63:179–191. November 22.

108. The art and practice of key-making in Entomology. Verhandl. XI Internat. Kong. Ent., Wien, 1960. 1:17–19. December (incorrectly 1962).

1962

109. *Gorytes (Gorytes) mcateei* Krombein and Bohart, new species, pp. 15–16. *In:* K. V. Krombein, Natural history of Plummers Island, Maryland, etc. Proc. Biol. Soc. Wash. 75:1–17. March 30.

110. New species of black *Tachysphex* from North America (Hymenoptera, Sphecidae). Proc. Biol. Soc. Wash. 75:33–39. March 30.

111. R. M. Bohart, D. H. Ecke, J. Fowler, and other collaborators. *In:* T. H. Lauret, ed., A field guide to common mosquito-like gnats of California. Ent. Committee, Calif. Mosq. Contr. Assoc., 19 pp.

112. R. M. Bohart and L. A. Stange. Lectotypes of Nearctic and Neotropical Zethini in European and American museums (Hymenoptera: Vespidae). Bull. Brooklyn Ent. Soc. 57:28–32. April 9.

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114. The *Tachytes pepticus* group in North America (Hymenoptera: Sphecidae). Pan-Pac. Ent. 38:117–129. June 29.
115. Book review: A catalogue and reclassification of the Indo-Australian Ichneumonidae by Henry Townes. Bull. Ent. Soc. Amer. 8:93–94. "June."
116. A new Strepsipteran parasitic on Coreidae (Strepsiptera: Halictophagidae and Hemiptera: Coreidae). Proc. Ent. Soc. Wash. 64:91–94. August 27.
117. A review of the hexadentate species of *Chrysis* of America north of Mexico (Hymenoptera, Chrysididae). Acta Hymenopterologica 1:361–375. September 30.
118. Vector control research at the University of California, Davis. Proc. Papers 30th Ann. Conf. Calif. Mosq. Contr. Assoc., pp. 29–30. October 22.

1963

119. New species of *Pseudomasaris,* pp. 290–292, 298–299, 301. *In:* O. W. Richards, The species of *Pseudomasaris* Ashmead (Hymenoptera: Masaridae). Univ. Calif. Publ. Ent. 27:283–310. July 3.
120. R. M. Bohart and A. S. Menke. A reclassification of the Sphecinae with a revision of the nearctic species of the tribes Sceliphronini and Sphecini (Hymenoptera, Sphecidae). Univ. Calif. Publ. Ent. 30:91–182. October 15.

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Gall-inducing Cynipid Wasps from *Quercus dunnii* Kellogg (Hymenoptera)

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The cynipid fauna on the oak *Quercus* (*Protobalanus*) *dunnii* Kellogg previously has received little study partly because of its restricted ecological and geographical distributions. *Quercus dunnii* occurs sporadically in the sagebrush-chaparral ecotone. Its range is a narrow horizontal band extending from southwest Arizona and northern Baja California, Mexico, around the western edge of the Mojave Desert (Tucker and Haskell, 1960), in San Benito County, California (Griffin and Tucker, 1976), and north to the inner coast range west of Byron, Contra Costa County, California (Tucker *et al.,* 1982).

The only prior cynipid host record for *Q. dunnii* (Weld, 1957) listed *Disholcaspis chrysolepidis* (Beutenmuller) and two undescribed stem galls. The present paper reports an additional 8 unisexual and 1 bisexual generation gall-inducing cynipid wasps including 4 newly described species (*Trichoteras burnetti, Loxaulus boharti, Heteroecus fragilis* and *Heteroecus lyoni*; all unisexual generations) and five new host records. Type specimens placed in the U.S. National Museum and the California Academy of Sciences are indicated with the abbreviations USNM and CAS respectively. Those placed in the L. H. Weld collection are in the possession of Robert J. Lyon, Los Angeles City College, Los Angeles, Calif.

BIOGEOGRAPHY

Q. dunnii has a highly disjunct relict distribution, occasionally only single trees. As is typical for island faunas each local oak population supports only a few cynipid species, particularly in the northern end of the range. This scattered distribution pattern provides a potential for rapid evolution and/or extinction of new species and requires widespread collecting to determine the current total fauna of this oak. The galls of numerous additional undescribed cynipids, probably the alternate bisexual generations, have been seen or collected from *Q. dunnii* but they will not be described until insects can be reared.

The 3 subgenera of American oaks have no gall-inducing cynipids in common, but most gall-inducing cynipids occur on more than 1 oak species within a subgenus. The cynipids on *Lepidobalanus,* or white oaks, and *Erythrobalanus,* or red and black oaks, of the Southwest and the Pacific slope are generally distinctive, with only 1 species known from both regions (R. J. Lyon, pers. comm.). But for some reason a different pattern occurs in the *Protobalanus* oaks. Some of the species listed in this paper on *Q. dunnii* occur in both the Pacific slope and the Southwest. An even more widespread distribution of the gall-inducing cynipids occurs on the more montane *Quercus chrysolepis* Leibmann. The cynipids on *Q. dunnii* with the widest geographic distribution are those which also occur on other *Protobalanus* oaks. The host patterns of these insects have not been generally appreciated because Weld (1960) routinely listed *Q. chrysolepis, Q. dunnii* and hybrids between these two species in Arizona all as *Q. wilcoxii.* In Weld (1957)

Quercus palmeri is a synonym of *Q. dunnii.* The differences in the evolutionary history of the three American oak subgenera and the atypical geographic pattern of the *Protobalanus* cynipid faunas in these two regions are not yet understood.

Trichoteras burnetti Dailey and Sprenger, New Species
(Fig. 2)

Unisexual generation female holotype.—Head: pubescent, reticulate; from above transverse; slightly narrower than thorax; cheeks widened behind eyes; occiput not elevated above general head contour; malar space 0.4 eye height, not grooved; antenna 13 segmented, filiform, segment 1 longer than 2, segment 3 equal to 4 or 1 plus 2, 13 twice the length of 12. Thorax: mesoscutum polished, micropunctate throughout, as broad as long, pubescent, profile normal; anterior parallel lines absent; notauli complete, close together throughout and nearly meeting posteriorly, twice as wide posteriorly as anteriorly; parapsidal lines and median groove absent; scutellum pubescent, punctate; fovea indistinct, coriaceous, weakly longitudinally ridged with slightly stronger median ridge; mesopleuron shiny, pubescent, punctate. Wings normal sized, hyaline, with fine pubescence, margin ciliate, veins light brown, radial cell open, aerolet 0.1 first cubital cell length. Claws toothed. Abdomen: propodeum smooth, polished, without median carina; length less than head plus thorax, tergites II and III smooth, polished, pubescent anteriorly; ventral spine stout but evenly tapering, 3 times as long as high or wide, bristly, shorter than basal hind tarsal segment. Using maximum head width as base, mesonotum length is 1.5, antenna 2.3, wing 5.5. Body length is 2.5 mm. Color of head, thorax, legs, and abdomen light brown, antennae brown, darkest distally.

Host.—*Quercus dunnii.*

Variation.—Size range of 28 specimens: 1.8–2.7 mm, average 2.1 mm.

Gall.—Yellow, highly pubescent aborted axillary bud or leaf petiole gall; polythalamous with angular basal larval cells; diameter 1.0–3.0 cm (Fig. 2 and Weld, 1957, Fig. 163).

Biology.—Pupation occurs in September. Insects reared by Burnett emerged during December and January and were observed to oviposit between axillary bud scales but no galls developed.

Type material.—Holotype ♀, 3 ♀ paratypes: CALIFORNIA, *Riverside Co.,* ca. 12 km E Anza, reared from 5 galls coll. from a single plant (Dailey #1263). Additional paratypes reared as follows: MEXICO, *Baja California* (*Norte*), El Condor (12 galls and 29 ♀, Dailey #1168); CALIFORNIA, *Riverside Co.,* 12 km E Hemet (4 galls, 43 ♀), Dr. John Burnett. All material in Dailey collection except holotype ♀ and 2 paratype ♀ and galls in USNM; 2 paratype ♀ and galls in CAS; 2 paratype ♀ in Weld collection.

Distribution.—In addition to the above localities, *T. burnetti* was recorded by Weld (1957) from galls collected in the San Jacinto Mountains, California on *Q. palmeri* (=*Q. dunnii*).

Discussion.—*Trichoteras burnetti* is the only gall on *Q. dunnii* which is polythalamous and covered with dense, thick pubescence and is the only bud or leaf-petiole gall. It resembles *Andricus lasius* McCracken and Egbert which occurs on other oak species. It is listed as species #2 in Weld's manuscript key to *Trichoteras* in the possession of Mr. Robert J. Lyon. Adult females may be distinguished from related species by the shorter ventral spine which is only 3 times as long as wide or high.

Etymology.—Named for Dr. John Burnett who first reared this species.

Trichoteras rotundula Weld: New Host Record
(Fig. 1)

This unisexual generation monothalamous, hollow, thin-walled, spherical leaf gall with central larval cell supported by filaments is attached to lower veins, occasionally in clusters (Fig. 1 and Weld, 1957, Fig. 91).

Host.—*Quercus dunnii, Q. chrysolepis.*

Biology.—Galls are fully grown by summer and females emerge in October and November. The insect specimens range from 2.0 to 2.6 mm in body length.

Distribution.—Specimens emerged from galls collected near Hemet Lake, Riverside County, California by Dr. John Burnett. Similar galls were collected by us at Sedona, Coconino County, Arizona and El Condor and Melling Ranch, Baja California (Norte), Mexico.

Andricus chrysobalani Weld: New Host Record

This is a bisexual generation which emerges from cells in the inner margins of the acorn cups and/or outer acorn hull during August. Insects emerged in mid-August from galls collected east of Anza, Riverside County, California (Dailey #1292). Similar galls were seen at Sedona, Coconino County, Arizona (Dailey #1289).

Andricus reniformis McCracken and Egbert: New Host Record

Galls of *Andricus reniformis* have been collected at Sedona, Coconino County, Arizona. These galls are similar to those of *Disholcaspis truckeensis* (Ashmead) which Weld recorded on "*Quercus wilcoxii*" in Arizona. Weld's listings of *Q. wilcoxii* include *Q. chrysolepis, Q. dunnii* or hybrids between these two oaks.

Disholcaspis chrysolepidis (Beutenmuller)

Disholcaspis chrysolepidis is a unisexual generation which produces an elongate stem gall, dark brown and convex on top and lighter in color and concave on both sides (Weld, 1957, Fig. 52). It has been found 10 km east of Anza, Riverside County, and 16 km northeast of Cajon Pass, San Bernardino County, California.

Disholcaspis truckeensis (Ashmead): New Host Record

Galls of *Disholcaspis truckeensis* were collected in the Haulaupi Mountains south of Kingman, Mojave County and Sedona, Coconino County, Arizona and from a single isolated tree 16 km northeast of Cajon Pass, San Bernardino County, California. This gall is similar to those of the bisexual generation of *Loxaulus trizonalis* Weld.

Hosts.—*Quercus dunnii, Q. chrysolepis,* and *Q. vaccinifolia* Kellogg.

The two species of *Disholcaspis* on *Protobalanus* oaks are distinctive from the other members in this genus (Burnett, 1977). This is also true for the 5 species of *Andricus* on *Protobalanus* oaks. All 7 species are sufficiently similar to each other that their life histories should be determined and their collective generic assignment reassessed.

Loxaulus boharti Dailey and Sprenger, New Species
(Fig. 3)

Unisexual generation female holotype.—Head: coriaceous; from above massive; broader than thorax; cheeks widened behind eyes; occiput rounded, only slightly elevated above contour of head; malar space 0.3 eye height, grooved, inner-ocular margins parallel; antenna 13 segmented, filiform, segment 1 longer than 2, segment 3 less than 4 or 1 plus 2, segment 13 twice the length of 12. Thorax: mesoscutum strongly transversely coriaceous, bare, as broad as long; sides of pronotum coriaceous; anterior parallel lines slightly less than 0.5 mesoscutum length; notauli incomplete, extending from posterior 0.3 mesoscutum length with short shallow depression anterior to that, wrinkled; parapsidal lines 0.4 mesoscutum length; median groove absent; scutellum weakly reticulate, slightly longer than wide; fovea indistinct, longitudinally wrinkled, separated by median wrinkle; mesopleuron aciculate. Wings pubescent, margin ciliate, veins brown, radial cell closed, aerolet 0.25 cubital cell length, basal and first abcissa of radial cell clouded. Claws simple. Abdomen: propodeum polished, slightly wrinkled, carinae straight, distinct, enclosing an area longer than wide, with distinct complete median carina; 2 tergites visible in dorsal view, length less than head plus thorax, slightly longer than high, smooth, polished, bare; ventral spine 3 times as long as high or wide. Using maximum head width as base, mesonotum length is 1.3, antenna 2.2, wing 3.5. Body length 1.8 mm. Color of head, thorax, legs, and abdomen yellow-brown; antennal segments 1–4 yellow-brown, 5–13 brown and ribbed.

Host.—*Quercus dunnii.*

Gall.—Integral stem gall, larval cells 2 mm in diameter, develop in wood under bark, stems slightly lumpy though lumps barely noticeable until insects emerge (Fig. 3). Similar to gall of *Loxaulus brunneus* (Ashmead) on *Quercus chrysolepis.*

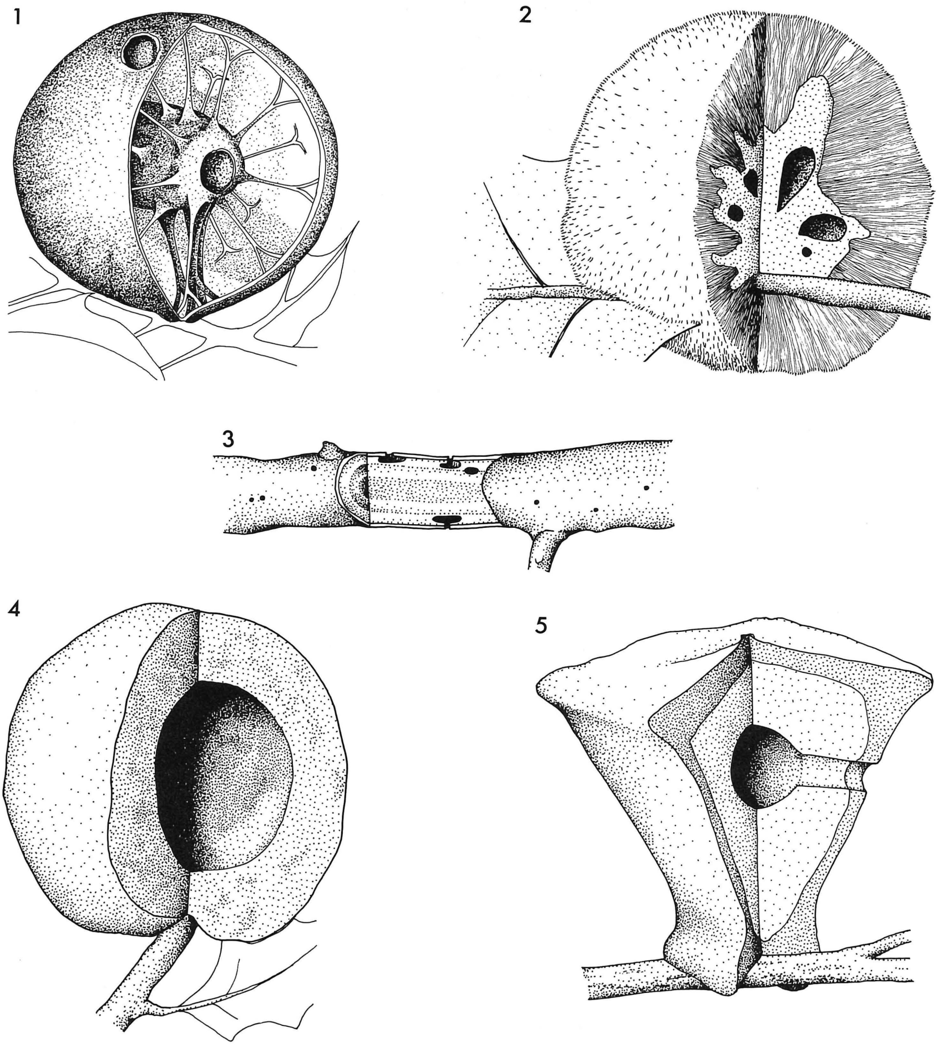
Variation.—Size range of 61 specimens 1.6–1.9 mm.

Biology.—Insects emerge in late March and early April from 2-year-old twigs and only the basal half of prior year twigs. The oviposition site is unknown but is probably in buds with bisexual generation emergence and oviposition in twigs when one-half of the current year's stem growth has occurred.

Type material.—Holotype ♀, 91 ♀ paratypes: CALIFORNIA, *San Diego Co.,* 1 km W Jacumba, reared from galls collected by us from a single shrub. All material in Dailey collection except holotype ♀, 2 paratype ♀ and 2 galls in USNM, 4 paratype ♀ and 4 galls each in CAS and Weld collections.

Distribution.—Galls similar to the above were collected at El Condor, Baja California (Norte), Mexico and 14 km east of Anza, Riverside Co., and 8 km west of Byron, Contra Costa County, California on *Quercus dunnii* and from San Carlos Canyon, Baja California (Norte), Mexico on *Q. cedrosensis* Muller. No insects were reared.

Discussion.—*Loxaulus boharti* is the only integral stem gall known from *Q. dunnii.* Adult females may be distinguished from *L. brunneus* (a similar gall-inducer on *Q. chrysolepis*) by the incomplete notauli and the ventral spine which



Figs. 1–5. Cynipid galls. 1, *Trichoteras rotundula.* 2, *T. burnetti.* 3, *Loxaulus boharti.* 4, *Heteroecus fragilis.* 5, *H. lyoni.*

is 3 times as long as wide or high. It keys to species 7 in Weld's manuscript key to *Loxaulus* in the possession of Robert Lyon.

Etymology.—This species is named for Dr. R. M. Bohart who has aided both of us in our studies of cynipids.

Heteroecus fragilis Dailey and Sprenger, New Species
(Fig. 4)

Unisexual generation female holotype.—Head: coriaceous; from above transverse; slightly narrower than thorax; cheeks not widened behind eyes; occiput flattened, elevated above the head contour; malar space 0.5 eye height, not grooved;

antenna 14 segmented, filiform, segment 1 longer than 2, segment 3 longer than 4 or 1 plus 2, segment 14 one and one-third times the length of 13. Thorax: mesoscutum coriaceous throughout; as broad as long, sparsely pubescent; anterior parallel lines distinct, slightly longer than 0.5 mesoscutum length, weak transverse rugosity between lines; notauli incomplete, extending from posterior 0.6 mesoscutum length, sharp edged, pitted; parapsidal lines distinct, from posterior 0.5 mesoscutum length; median groove weak, 0.2 mesoscutum length; scutellum irregularly rugose, sparsely pubescent; fovea wrinkled, polished, bare, separated by a ridge; mesopleuron aciculate, bare. Wings hyaline, setae not projecting beyong margin, veins yellow, radial cell open, aerolet 0.3 length of first cubital cell. Claws simple. Abdomen: propodeum with weak median carina; length greater than head plus thorax, tergum II smooth, polished, bare dorsally, slightly pubescent anteriolaterally, micropunctate on posterior margin; ventral spine 10 times as long as high. Using maximum head width as base, mesonotum length is 1.3, antenna 2.3, wing 4.0. Body length is 2.7 mm. Color of head, thorax, legs, and abdomen dark red-brown, first six antennal segments yellow-brown, antennal segments 7–14 brown.

Host.—*Quercus dunnii.*

Gall.—Detachable, monothalamous stem gall with a thick wall formed from many small, fragile, sponge-like chambers. Yellow, spherical, 5–8 mm in diameter (Fig. 4).

Biology.—Insects had emerged from most galls collected 29 March 1972, however the collection did yield one adult insect. Oviposition site of the unisexual generation is unknown. Gall position indicates the eggs for the unisexual generation are laid in buds in the spring or early summer.

Type material.—Holotype ♀: MEXICO, *Baja California* (*Norte*), El Condor, reared from gall on *Quercus dunnii* (Dailey #1239). Paratype galls: ARIZONA: 3, *Mojave Co.,* Haulaupi Mountains. CALIFORNIA: 1, *San Luis Obispo Co.,* Paso Robles. MEXICO: *Baja California* (*Norte*): 3, Mike's Sky Ranch; 48, El Condor; 4, Melling Ranch. All specimens in Dailey collection except holotype ♀ and 4 paratype galls in USNM, 4 paratype galls in CAS, and 2 paratype galls in Weld collection.

Discussion.—*Heteroecus fragilis* is the only gall on *Q. dunnii* which is monothalamous, spherical, and has thick, spongy walls (Fig. 4). *Trichoteras burnetti* (Fig. 2) is spherical but is polythalamous with thick pubescence and *T. rotundula* (Fig. 1) is spherical but is hollow, with paper-thin walls. *Disholcaspis truckeensis* is spherical but is polythalamous.

Etymology.—This species is named for the fragile gall texture.

Heteroecus lyoni **Dailey and Sprenger, New Species**

(Fig. 5)

Unisexual generation female holotype.—Head: coriaceous; from above transverse; narrower than thorax; cheeks not widened behind eyes; occiput flattened, elevated above contour of head; malar space 0.5 eye height, not grooved; antenna filiform, 14 segmented, segment 1 longer than 2, segment 3 longer than 4 or 1 plus 2, segment 14 one and one-half times the length of 13. Thorax: mesoscutum coriaceous, broader than long, sparsely pubescent; anterior parallel lines distinct, more than 0.5 mesoscutum length; notauli incomplete, from posterior 0.7 mesoscutum length, smooth, polished; parapsidal lines distinct, extending from posterior 0.5 mesoscutum length; median groove indistinct, 0.1 mesoscutum length; scutellum rugose, sparsely pubescent; fovea smooth, polished, bare, separated by a ridge; mesopleuron aciculate. Wings hyaline, setae not projecting beyond margin, veins yellow-brown, radial cell closed, aerolet 0.2 first cubital cell length. Claws simple. Abdomen: propodeum reticulate, pubescent, without median carina; length greater than head plus thorax; tergum II smooth, polished, bare, very short pubescence on ventral-posterior edge of tergum II; ventral spine long and thin, 10 times as long as high or wide, evenly tapering, sparsely pubescent. Using maximum head width as base, mesonotum length is 1.4, antenna 2.5, wing 5.4. Body length is 2.5 mm. Color of head, thorax, and abdomen is red-brown, legs and antennae are yellow.

Host.—*Quercus dunnii.*

Gall.—Detachable, monothalamous, hard, brown stem gall about as wide as tall with flaring sides and flat top 5–11 mm in diameter with an elevated central spot (Fig. 5, see also Weld, 1957, Fig. 164).

Variation.—Body length range of 27 specimens is 2.3 to 2.7 mm, average 2.6 mm. Both insects from Paso Robles have lighter colored wing veins. The color range for specimens from 8 miles east of Hemet is from amber to dark brown. Mesoscutum texture occasionally approaches weak transverse rugosity. Galls from Paso Robles and Clear Creek, San Benito County, California and some from El Condor, Baja California Norte, Mexico have nearly straight ribbed sides and a depressed central top. Those developing from axillary buds typically have a groove on the side adjacent to the stem.

Biology.—Mature galls were collected in November and insects emerged indoors in the rearing containers in late winter or early spring. The oviposition site and alternate generation are unknown.

Type material.—Holotype ♀, 12 ♀, 3 gall paratypes: MEXICO, *Baja California* (*Norte*), El Condor, C. Dailey. Additional paratypes as follows: MEXICO, *Baja California* (*Norte*), Mike's Sky Ranch. CALIFORNIA, 5 ♀, 28 galls, *Riverside Co.,* 10 km E Anza, C. Dailey; 2 ♀, 68 galls, *San Luis Obispo Co.,* Clear Creek, J. Tucker. All specimens in Dailey collection except holotype ♀, 4 paratype ♀ and galls each in USNM, 4 paratype ♀ and galls each in CAS and Weld collections.

Discussion.—*Heteroecus lyoni* is the only gall on *Q. dunnii* with the peculiar flaring sides and flat top as shown in Fig. 5. *Disholcaspis chrysolepidis* might rarely be confused with *H. lyoni,* but the former is mushroom-shaped and usually occurs clumped together in rows.

Etymology.—This species is named in honor of Mr. Robert J. Lyon who has worked out many cynipid life cycles including the first *Heteroecus* life history. He has provided much valuable assistance and encouragement in these studies.

Heteroecus pacificus **Kinsey: New Host Record**

Galls of this species were seen at Sedona, Coconino County, Arizona (Dailey #1289). The known hosts now include *Quercus dunnii, Q. chrysolepis, Q. tomentella* Engelmann, and *Q. vaccinifolia* Kellogg.

Acknowledgements

The authors are grateful to Dr. Richard M. Bohart, whose efforts as an instructor made this paper possible, to Dr. John M. Tucker for the Clear Creek, California specimens, Dr. John Burnett for use of his reared specimens and Robert J. Lyon for use of the Weld collections and manuscript keys, and M. Lynn Kimsey for illustrations.

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Diodontus boharti, a New Species from California's North Coast Range (Hymenoptera: Sphecidae)

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Collecting trips to the more remote portions of California's Siskiyou Mountains, Marble Mountains, Salmon Trinity Mountains, and Yolla Bolly Mountains since 1965 have added more than 30,000 specimens to the insect collection at Pacific Union College, Angwin, Napa County, California. Most of the collecting expeditions involved small groups of students who, with the author, spent about ten days at a time backpacking into the higher elevations in search of insects. The North Coast Ranges of California have a unique flora that has been described as rich in narrowly endemic species which often appear to be relicts restricted to a specific ecosystem (Whittaker, 1961). We assumed that in an area so vegetatively and geologically distinctive, we would also find a characteristic insect fauna. More than 15 years of collecting in these mountains has resulted in a number of new species and new distributional records. We suspect that there are more, but large portions of the collection have not yet been determined to species and we are still looking for systematists who would be willing to determine material for us.

Determination of wasp specimens from our collections has been done mostly by Dr. Richard Bohart. My first contact with him was in connection with a new species of *Pulverro* that I discovered in the Salmon Trinity Mountains in 1966 (Eighme, 1968). I was a bit hesitant to attempt my first description and publication of a new species, but Dr. Bohart took care of that with his good natured assurance and assistance. My immediate reaction was one of confidence with such authority as he telling me I had a good species. *Pulverro monticola* Eighme has since been collected over a wide area of northern California mountains.

It was Richard Bohart who encouraged me to work on the genus *Diodontus.* I am grateful to him for introducing me to this fascinating group of wasps and I take pleasure in naming this distinctive new species in his honor.

Diodontus boharti Eighme, NEW SPECIES

Holotype male.—Black; mandibles (central portion), palps, apical ½ of pronotal lobe, spot on anterior portion of tegula, front side of all tibiae golden yellow; basal tarsomere of foreleg dusky yellow; wings dusky, iridescent, wing veins and stigma dark brown; labrum shallowly notched, clypeal teeth prominent; flagellomeres V–X with apical margins arcuate, flagellomeres VIII–X with oval, smooth, shiny tyli, flagellomere XI with small basal tylus and apical smooth shiny spot; frons and vertex with large punctures separated by less than puncture diameter, microsculpture finely linear, upper ½ of frontal line a weak carina; pronotal collar with humeral angles sharp but not produced upward; scutum with dense punctures slightly smaller than those on the head, no microsculpture, admedian lines prominent, raised and broader than the notauli which are also prominent, parapsidal lines obscure; scutellum with faint median line; propodeum coarsely reticulate with blunt lateral spine posterad from the spiracular flange; abdomen with fine setigerous punctures connected by fine reticulated microsculpture, tergum VI with spinose tubercules on posterior margin bearing 3 spines, sternal brushes weak; basal tarsomeres straight; omaulal ridge strong, sharp, joining postspiracular carina by a lateral extension at right angle.

Allotype female.—Black; mandibles (central portion), spot on anterior portion of tegula golden yellow; palps brown; tibiae orange-brown with darker spot on posterior side; wings dusky, iridescent, wing veins and stigma black; clypeal teeth prominent, lateral teeth twice as long as medial one; frontal spine prominent but blunt, orbital foveae narrow, extending from mid-orbit to vertex; frons and vertex with widely scattered large punctures, microsculpture fine reticulation; pronotal collar with coarse longitudinal striations at crest, humeral angles slightly winged; scutum with widely scattered punctures of same size as those on vertex plus smaller punctures densely concentrated on anterior portion, admedian lines distinct, notauli faint, parapsidal lines long, distinct; scutellum punctured like posterior scutum, propodeum coarsely reticulate with blunt lateral spine; abdomen finely punctured with reticular microsculpture; omaulal carina similar to male but not as prominent; pygidium flat with lateral border of coarse white setae.

Type material.—Holotype ♂ and allotype ♀: CALIFORNIA, *Siskiyou Co.,* Bear Basin, 7000′, August 9, 1967, Lloyd Eighme, deposited at California Academy of Sciences, San Francisco. There are 21 paratypes as follows (all from California, all deposited at Pacific Union College, except as noted): *Del Norte Co.,* Stevens Camp; *Glenn Co.,* Plaskett Meadows; *Siskiyou Co.,* Rattlesnake Meadow; *Trinity Co.,* Deadfall Lakes, Mirror Lake, Red Mt. Meadows, Swift Creek (University of California, Davis), Ward Lake.

Discussion.—The coarse sculpturing of the frons and vertex is distinctive in this species. *D. boharti* resembles *D. vallicolae* in some ways but differs markedly in that it lacks the modified scutal margin seen in *D. vallicolae,* and the male has spinose tubercles on tergum VI which relate it to a different species group. Coloration may vary from the holotype in that darker specimens have no yellow on the pronotal lobe or tegula. Varying amounts of yellow pigmentation is evident in most species of this genus, so that structural characteristics have been selected as much as possible to separate the species. I originally recognized this new species from a few specimens I collected in Bear Basin, Siskiyou County in 1967. One of my students, Terry Griswold, collected 23 specimens in the Swift Creek area of Trinity County in 1972, and since then other specimens have been taken at various sites in the North Coast Range.

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The Larva of *Ammatomus icarioides* (Turner) (Hymenoptera: Sphecidae, Nyssoninae)

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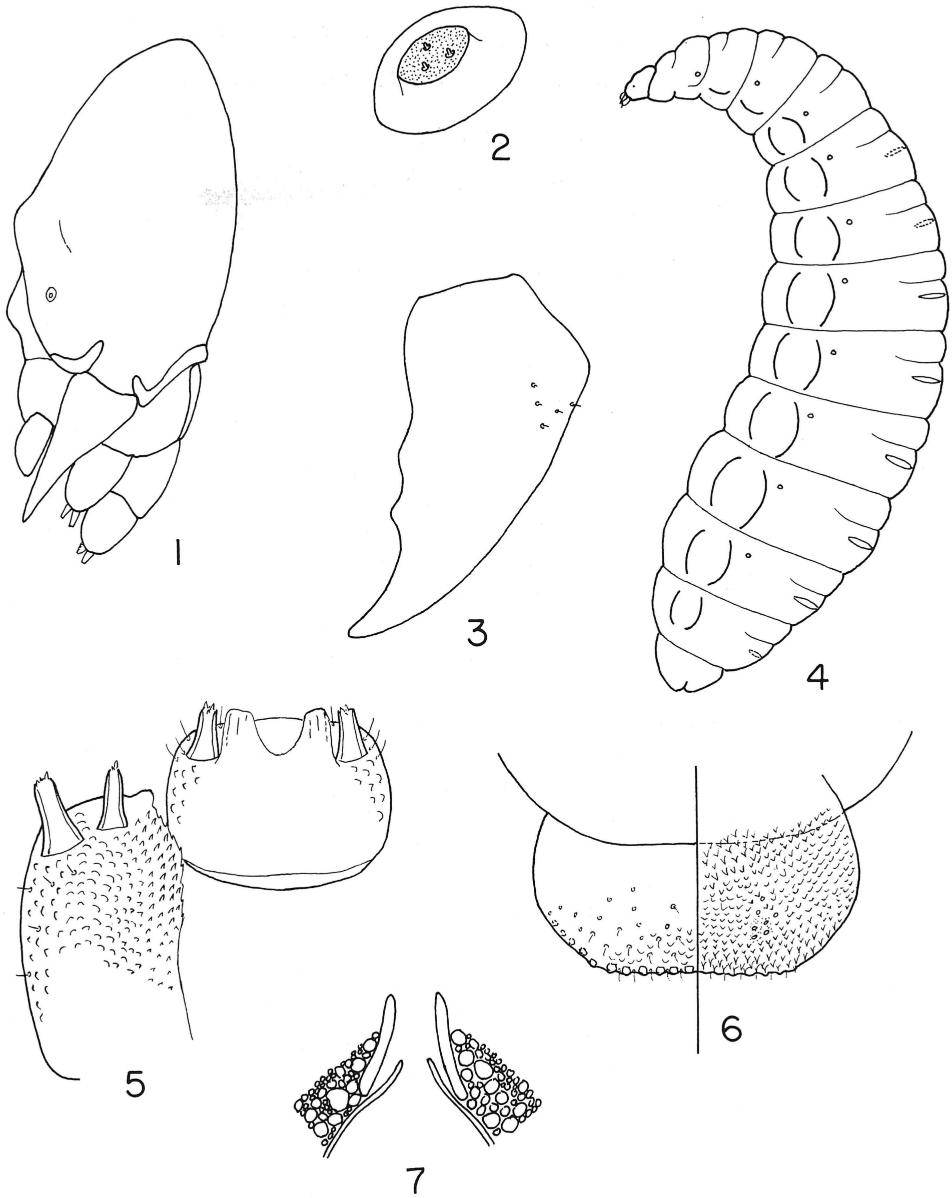
There are few groups of insects more rewarding to ethologically inclined biologists than digger wasps. They were favorites of Fabre, and since his time they have been the subject of innumerable books and scientific papers. Yet for many years Sphecidae were taxonomically a forbidding group, in which accurate species identifications were hard to come by and the higher classification fraught with difficulties. Problems still exist, and perhaps always will, but the picture has changed dramatically for the better, thanks in large part to Richard Bohart and the many students he has trained. The rewards of this research and teaching will be reaped for many years in terms of increased depth of knowledge of these most elegant of insects.

The present paper purports to fill only a tiny gap in our understanding of sphecid phylogeny. In fact it poses a puzzle, for the larvae of *Ammatomus* have several unusual features which tend to contradict evidence from ethology and from adult structure. Nesting data (Hook, 1981) suggest that *Ammatomus icarioides* is a fairly typical member of the tribe Gorytini, while adult morphology suggests that it belongs to a complex of gorytine genera (including *Sphecius, Kohlia,* and others) having a rather robust thorax, approaching the Stizini (Bohart and Menke, 1976).

This study is based on seven larvae from Brisbane, Queensland, Australia, taken by Allan Hook in his recent biological study. Several cocoons from this study were also available. Voucher specimens have been placed in the Colorado State University Collections. Associated adults were identified by comparison with the type specimen in the British Museum (Natural History).

DESCRIPTION OF MATURE LARVA
(Figs. 1–7)

Body length 16 mm; maximum width 4.2 mm (Fig. 4). Integument smooth and largely devoid of setae and spines, although under high magnification scattered minute setae and surface granules can be detected. Each body segment divided dorsally into two annulets by a transverse crease, the most posterior annulet with a pair of weakly defined transverse welts; pleural lobes well developed; anus terminal. Ten pairs of equally developed spiracles present; atria lined with hexagonal cellules; opening into subatrium armed with a circlet of spines. Maximum width of head 1.04 mm; length to apex of clypeus 1.08 mm, to apex of labrum 1.3 mm. Front of head with five somewhat nipple-shaped callosities, three of them in a series just below and mesad of antennae, two somewhat above antennae (these callosities are slightly brownish in color in two specimens, unpigmented in the other five). In lateral view (Fig. 1) only two of these callosities are visible. Coronal suture distinct; parietal bands indicated by short, unpigmented streaks.



Figs. 1–7. *Ammatomus icarioides.* 1–6, mature larva; 7, cocoon. 1, head, lateral view. 2, antenna. 3, mandible. 4, body, lateral view. 5, labium and maxilla, oral aspect. 6, labrum (left half) and epipharynx (right half). 7, diagrammatic cross section of cocoon pore.

Antennal orbits small, circular, containing a circular brown area in the center; this brown disc is slightly elevated above the membrane of the orbit and bears three small sensilla (Fig. 2). Head with scattered punctures, some of which bear minute setae no more than 3 times as long as width of puncture; clypeus with 24 punctures in lateral groups of 12 each.

Labrum 0.43 mm wide, apical margin straight, with a row of 22 small sensory cones; surface strongly convex, with 20 punctures on each side, most of them bearing short setae; apical margin also with several setae; surface papillose medioapically (Fig. 6). Epipharynx strongly spinulose, sensory areas each with 7 pores. Mandibles 2.1 times as long as their greatest width, weakly tridentate, each with 5 punctures toward the base laterally, punctures bearing minute setae (Fig. 3). Maxillae with small setae laterally, extensively papillose but papillae grading into small spinules on mesal margin; palpi and galeae prominent, palpi slightly longer and stouter than galeae (Fig. 5). Labial palpi equal in length to galeae, but somewhat stouter; spinnerets paired, not exceeding palpi; labium with several prominent apical setae.

Discussion

Although the nesting biology of *Ammatomus icarioides* appears to differ in no important ways from that of *Gorytes* and related genera, the larva will not key readily to Gorytini in either the artificial key of Evans (1959) or the tables of Evans and Lin (1956). This is because of the absence of a distinct antennal papilla and the five protuberances on the front of the head. These protuberances are not as distinct as in Alyssonini and Nyssonini, but they are better developed than the "two pairs of vertical depressions" and the resulting interspaces described for *Gorytes.* The unusual antennae are difficult to explain. They appear to represent a stage between the development of a true papilla and the presumably ancestral condition, in which the sensilla merely arise from the membrane of the orbits.

The cocoons provide no assistance in solving this puzzle. As noted by Hook (1981), there is a single pore with a raised rim at one end. This is actually at the posterior end, opposite the cap, and resembles the pore in the cocoon of *Gorytes,* as figured by Evans (1966). This pore penetrates both the outer and inner layers of the cocoon and has a thickened rim (Fig. 7). It may represent a precursor of the more elaborate pores of *Sphecius* and of Bembicini, which are distributed around the widest part of the cocoon. In any case, there seem to be no important differences between the cocoons of *Ammatomus* and those of *Gorytes.*

We are left with the conclusions that the larvae of *Ammatomus* have probably been subjected to somewhat different selection pressures than those of other Gorytini and that the genus perhaps stands somewhat farther apart phylogenetically from *Gorytes* and from *Sphecius* than usually recognized.

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Two New Species in the Genus *Philanthus* and a Key to the *politus* Group (Hymenoptera: Philanthidae)[1]

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Bohart and Grissell (1975) arranged the North American *Philanthus* into seven species groups and provided a key for the identification of the species. An undescribed species belonging to their *P. politus* group was contained in a collection of philanthine wasps received for identification in 1980 from F. D. Parker (USDA, Bee Biology and Systematics Laboratory, Utah State University, Logan). Since this new species was difficult to place in their key, a study of the *P. politus* group was undertaken with the objective of preparing a key to accommodate the new species. A consequence of this study was the finding that the holotype of *Philanthus serrulatae* Dunning is a male of the species previously known as *Philanthus siouxensis* Mickel, a member of the *P. politus* group. The species in the *P. pacificus* group to which Bohart and Grissell (1975) had applied the name *P. serrulatae*, nec Dunning, is thus left without a name.

In Part I of this paper *P. siouxensis* is synonymized under *P. serrulatae*, and *Philanthus boharti* new species is described in the *pacificus* group to provide a name for the species previously known as *P. serrulatae*, nec Dunning. In Part II *Philanthus parkeri* new species is described in the *politus* group; the *politus* group is redefined to include *Philanthus ventilabris* Fabricius; and a key to the *politus* group is presented. Abbreviations used for institutional repositories are explained in Acknowledgments.

PART I. THE IDENTITY OF *PHILANTHUS SERRULATAE* DUNNING AND DESCRIPTION OF A NEW SPECIES IN THE *PHILANTHUS PACIFICUS* GROUP

Strandtmann (1946) treated several taxa in the genus *Philanthus* as subspecies of *Philanthus politus* Say. Bohart and Grissell (1975) synonymized *Philanthus texanus* Banks under *P. politus* and elevated the remainder of Strandtmann's subspecies to species. They placed *P. politus, P. psyche* Dunning, *P. siouxensis,* and *P. tarsatus* H. Smith in their *politus* group; and they placed *P. barbiger* Mickel, *P. pacificus* Cresson, *P. pulcher* Dalla Torre, and *P. serrulatae* in their *pacificus* group. The *politus* group has a metapleural lamella (= metanotal lamina of Strandtmann), whereas this structure is lacking in the *pacificus* group. This placement of *P. serrulatae* was in accord with that of Strandtmann (1946 in key, couplet 27) who stated "No metanotal lamina . . ." in characterizing the species.

Four of the specimens to which Strandtmann (1946) referred in his discussion of *P. serrulatae* were studied (OSU). Three of these (10 mi. e. Santa Fe, New Mexico; Lusk, Wyoming; Clear Creek, Colorado) have a metapleural lamella and are males of *Philanthus siouxensis.* The male from Clear Creek, Colorado, bears

[1] Oregon Agricultural Experiment Station Technical Paper No. 6589.

a label "Compared with type *P. serrulatae* D." The fourth specimen (Imperial County, California) is a male without a metapleural lamella and is conspecific with *P. serrulatae,* nec Dunning, as interpreted by Bohart and Grissell (1975). An additional five males, from Imperial County and Los Angeles, California [USNM], that Strandtmann (1946) had referred to *P. serrulatae* were also examined and found to be conspecific with the *P. serrulatae,* nec Dunning, of Bohart and Grissell (1975). It was apparent that Strandtmann had two species before him. The male holotype of *P. serrulatae* was studied and found to be a male of *P. siouxensis* and conspecific with the above males from New Mexico, Wyoming and Colorado.

Philanthus serrulatae **Dunning**

Philanthus serrulatae Dunning, 1898:154. Male holotype, Denver, Colorado; ANSP.
Philanthus siouxensis Mickel, 1916:406. Female holotype, Harrison, Nebraska; NEB. Bohart and Grissell, 1975:6,7 (in key); Bohart and Menke, 1976:566; Krombein, 1979:1725. **New Synonymy.**
Philanthus politus serrulatae, Strandtmann, 1946:83 (in part).
Philanthus politus siouxensis, Strandtmann, 1946:91.

Specimens examined.—71 ♂, 82 ♀, including the male holotype of *P. serrulatae* and two female paratypes of *P. siouxensis.*

Distribution.—From South Dakota and Wyoming south through the Rocky Mountains and high plains to Arizona, New Mexico and Texas. In Mexico it occurs in the states of Chihuahua, Coahuila, Durango, San Luis Potosi, Zacatecas, Aguascalientes and Mexico. From Colorado northward dates of capture are mostly in July, whereas it has been collected from April to October in the southern part of its range.

Discussion.—The above synonymy leaves the *P. serrulatae,* nec Dunning, of Bohart and Grissell (1975) without a name. It is a member of the *pacificus* group, as defined by Bohart and Grissell (1975), and is described herewith.

Philanthus boharti **Ferguson, New Species**

Philanthus politus serrulatae, Strandtmann, 1946:83 (in part).
Philanthus serrulatae, Bohart and Grissell, 1975:17; Bohart and Menke, 1976: 566; Krombein, 1979:1725.

Bohart and Grissell (1975) keyed, figured and discussed this species under the name *P. serrulatae* (nec Dunning) and both sexes run to *P. serrulatae* in their key.

Diagnosis.—Both Sexes: Length 7–9 mm; inner eye margins parallel below the emargination; maximum head width 1.5 times width of face at apex of eye emargination; interocellar distance greater than ocellocular distance; metapleural lamella absent; forewing costa whitish, at least at base; punctures on terga II–III about same size as scutal punctures; pale transverse band on terga IV–V biemarginate anteriorly; pale markings whitish with few tinges of yellow. *Male:* clypeal brushes whitish, separated medially by half the length of a brush; malar space about equal to width of pedicel; upper half of face below midocellus with punctures separated by 1 or 2 puncture diameters and microridges weak or obscure; vertex width at midocellus greater than half the interocular distance at widest part of clypeus; femora usually with a red tinge at juncture of black basal portion and white apical portion. *Female:* malar space less than half the width of pedicel; area laterad of midocellus sparsely punctured; femora usually black, red and white, or all red.

Types.—Holotype ♂: CALIFORNIA, *San Diego Co.,* Borrego Springs, April 26, 1964 (G. & A. Ferguson, CAS). Paratypes: 100 ♂, 87 ♀ from CALIFORNIA, *San Diego Co.,* as follows: 3 ♂, 4 ♀, same data as holotype; 2 ♂, 3 ♀, same as holotype except April 27, April 28, April 29; 1 ♂, 1 ♀, Borrego Springs, III-30-60 (M. Wasbauer); 1 ♀, Borrego Springs, III-31-73 (C. Goodpasture); 3 ♂, Borrego Valley, sweeping alfalfa, III-26-59 (A. A. Grigarick); 59 ♂, 43 ♀, Borrego Valley, IV-11-62, IV-6-64, V-23-64, IV-11-69, IV-9-70, IV-2-73 (R. M. Bohart, C. Goodpasture, E. E. Grissell, J. E. Slansky, M. Wasbauer); 15 ♂, 9 ♀, Borrego Valley, dunes, IV-18-57, IV-20-57 (R. C. Bechtel, R. M. Bohart, J. C. Hall, H. E. Moffitt, E. I. Schlinger); 8 ♂, 9 ♀, Borrego Valley, Coyote Creek, III-26-59, IV-5-63 (R. M. Bohart, A. A. Grigarick, M. E. Irwin, F. D. Parker); 1 ♂, Borrego State Park, III-28-77 (J. Slansky, M. Wasbauer); 1 ♂, Borrego State Park, IV-17/20-69, *Acacia greggi* (R. R. Pinger); 6 ♀, Borrego State Park, IV-17/20-69 (M. S. & J. S. Wasbauer); 7 ♂, 11 ♀, Borego [sic], IV-1-53, IV-25-54, IV-27-54, IV-29-54, IV-24-55, IV-26-55, IV-27-55 (P. D. Hurd, M. Wasbauer). [AZS, UCB, UCD, CAS, CDA, UID, LAM, OSU, USNM, USU].

Other specimens examined.—131 ♂, 121 ♀ in addition to the type series. [AZS, UCB, UCD, CAS, CDA, UID, LAM, OSU, USNM, USU].

Distribution. Mostly in Lower Sonoran deserts from San Diego and Imperial Counties north to Mono County, California; Clark County, Nevada; Washington County, Utah; and Mohave and Yuma Counties, Arizona. In Mexico, it occurs in northwestern Sonora (El Golfo; Sonoita; 39 mi. n. Puerto Penasco); Baja California Norte (Bahia de los Angeles; Rosarito; Mexicali; San Felipe); and in Baja California Sur (Guerrero Negro) near the border with Baja California Norte.

Flight period. Most dates of capture are from March to May with a peak in April. A partial second brood is indicated by several October captures as follows: California: 2 ♀, San Bernardino Co., 25 mi. s. Ivanpah, X-12/13-58 [UCB]; 1 ♀ Imperial Co., 2 mi. s. Palo Verde, X-18-59 [UCB]; 1 ♂, San Diego Co., 13 mi. e. Borrego Springs, X-7-67 [AZS]. It may also be bivoltine in the Baja California peninsula as indicated by a male captured on II-24-74 (Guerrero Negro) [USU] and a female taken on VIII-5-73 (22 mi. s. Rosarito) [LAM]. A male and 2 females were collected at black light near El Golfo, Sonora, Mexico, IV-10-73 [CDA].

Etymology.—I am pleased to dedicate this species to Dr. Richard M. Bohart in recognition of his contributions to our knowledge of aculeate Hymenoptera, and especially for his helpful advice and encouragement in behalf of my current studies. Upon calling the *P. serrulatae* synonymy to his attention he suggested that I proceed to publish it.

Discussion. Among the small, finely punctured species of *Philanthus* with an anteriorly biemarginate pale band on terga IV–V, *P. boharti* closely resembles *P. psyche* and *P. serrulatae* in the *politus* group, and *P. pacificus* (= *P. arizonae* Dunning) and *P. pulcher* in the *pacificus* group. Since the metapleural lamella is sometimes quite small in *P. psyche* and *P. serrulatae,* the following comments may be helpful in separating the species. The metapleural lamella is almost always pigmented in *P. psyche,* and in these cases recognition of the structure is relatively easy.

The distinct malar space separates males of *boharti* from *pacificus* and *psyche,* but not from *pulcher* and *serrulatae.* In *pulcher* the forewing costa is reddish to brown to the base, and the interocellar distance is no greater than the ocellocular distance. In *serrulatae* the ocellocular distance is greater than the diameter of the midocellus, whereas in *boharti* the ocellocular distance and the midocellus diameter are subequal. In females the interocellar distance and ocellocular distance are subequal in *pulcher* and *serrulatae,* whereas the interocellar distance is always distinctly greater than the ocellocular distance in *boharti, pacificus,* and *psyche.* The metapleural lamella separates *psyche* from the other two species.

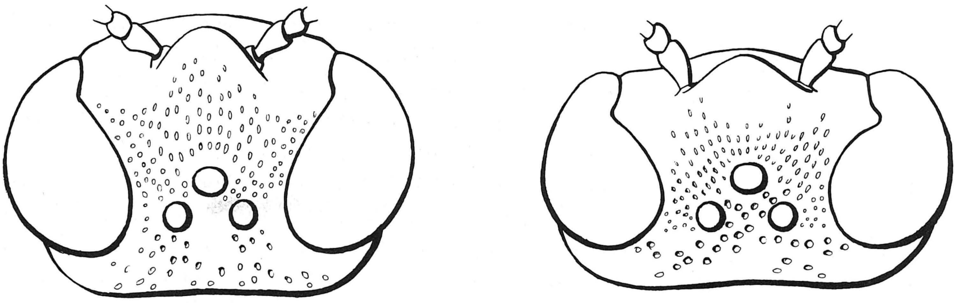
Bohart and Grissell (1975) discussed the problem of separating females of *boharti* from red-legged females of *pacificus.* The problem is further complicated by the presence of females of *boharti* without reddish markings on the femora (Old Woman Springs, San Bernadino County, California, IV-17-62; UCB). In *boharti* the tergal punctures are somewhat sparser and more irregularly spaced than in *pacificus* (see Bohart and Grissell, 1975, Figs. 25–28). Head measurements show that the eyes of *pacificus* are somewhat more swollen than in *boharti.* The ratio between least vertex width and width of face at the apices of the eye emarginations is the same for both species, but the maximum head width is 1.6 times the facial width in *pacificus* and only 1.5 times the facial width in *boharti.* There is virtually no overlap in the measurements (n = 10). In addition, the two species are largely allopatric with *boharti* being a Lower Sonoran species and *pacificus* an Upper Sonoran and Transition zone form.

Part II. The *Philanthus politus* Group

In this section *Philanthus parkeri* new species, belonging to the *politus* group, is described; the *politus* group is redefined to include *Philanthus ventilabris*; and a key to the *politus* group is presented.

Philanthus parkeri **Ferguson, New Species**
(Figs. 1, 2)

Male.—Length 5–7 mm, forewings 4–6 mm; malar space at least ¾ as long as width of pedicel; clypeal brushes whitish, separated medially by half the length of a brush; antennal sockets separated from eye margins by about 2 socket diameters and from each other by about 3 socket diameters; maximum width of head 1.5 times width of face at apex of eye emargination and 2.7 times least width of vertex; face at apex of eye emargination 1.8 times least width of vertex; ocellocular distance about equal to diameter of lateral ocellus and distinctly less than diameter of midocellus; flagellomere I about as long as combined length of scape and pedicel; interantennal groove weak to absent; upper face densely punctured with numerous microridges, sculpture continuing into area between midocellus and eye margin; ocellar triangle with few large, setigerous punctures of about the same size as those behind the ocelli; pubescence of lower face and clypeus bristly, recumbent to sub-recumbent; dense, setigerous punctures of lower face continuing onto adjacent margins of clypeus, remainder of clypeus very sparsely punctate; pronotal ridge thick, rounded; scutal punctures dense antero- and posteromedially, separated and irregular elsewhere, pit-like; scutellum sparsely punctate, groove obscure or absent; metapleural lamella prominent, pigmented; subalar carina variably pigmented, with prominent translucent lamellae laterally; propodeal en-



1 2

Figs. 1, 2. *Philanthus parkeri,* dorsal view of head. 1, male. 2, female. Actual head width 1.9 mm for male and 2.2 mm for female.

closure with large patch of punctures on each side, furrow more densely and irregularly sculptured; many punctures on tergum II smooth-rimmed and larger than scutal punctures; sterna III to V with coarse punctures mostly separated by less than 1 puncture diameter; lateral pubescence on sterna IV and V whitish, not dense; without patches of dense pubescence on sterna VI or VII.

Female.—Length 6–8 mm, forewings 5–7 mm; malar space ¼ to ⅕ pedicel width; antennal sockets separated from eye margin by about 1.5 socket diameters and from each other by about 2.5 socket diameters; maximum width of head 1.6 times width of face at apex of eye emargination and 2.6 times least width of vertex; ocellocular distance 1.1 times diameter of lateral ocellus and 0.9 times diameter of midocellus; interocellar distance 1.2 times diameter of midocellus; flagellomere I longer than scape; sculpture as in male.

Coloration.—Pale markings mostly bright yellow with occasional whitish blotches; males almost entirely yellow in dorsal view, with black band across the ocellar area often present, three narrow black stripes usually indicated on scutum; median black stripe on popodeum usually present; prosternum, mesosternum and metapleural area black; legs mostly yellow except femora basally, trochanters and large spot on coxae black; tarsi yellow to reddish; wings clear hyaline, veins fulvous to reddish; narrow anterior black bands on apical terga; sterna II to V with yellow bands or large spots. Female colored much like male except that black area of vertex extends laterally down inner orbits to antennal sockets, scutum with 3 broad longitudinal black stripes, and more extensively black on propodeum. Tergum VI in female and terga VI and VII in male extensively yellow. Terga IV and V not biemarginate anteriorly.

Types.—Holotype ♂: UTAH, *Emery Co.,* 2 mi. n. Goblin Valley State Preserve, 5000 ft., Aug. 25, 1980 (A. S. Menke, F. D. Parker, Kurt A. Menke, USNM). Paratypes: 26 ♂, 67 ♀, all from *Emery Co.,* UTAH, as follows: 5 ♂, 3 ♀, same data as holotype; 8 ♂, 63 ♀, Goblin Valley, in sand dunes, IX-16-79, IX-16-80 (T. Griswold, F. D. Parker, D. Veirs); 13 ♂, 1 ♀, San Rafael Desert, Little Gilson Butte, 5000–5100 ft., VIII-19, 24-27-1980 (A. S. Menke, F. D. Parker, Kurt A. Menke) [UCD, CAS, UID, OSU, USNM, USU].

Other specimens.—27 ♂, 6 ♀, as follows: ARIZONA: *Coconino Co.:* 15 mi. n.

The Gap, IX-21-66, 1 ♀ (R. Rust, P. Torchio, G. Wood, N. Yousef, USU). IDAHO: *Butte Co.:* 7 mi. e. Howe, IX-6-67, 12 ♂ (W. F. Barr, UID). *Lincoln Co.:* 5 mi. e. Dietrich, IX-2-65, 1 ♂, 1 ♀ (R. L. Westcott, UID); 7 mi. e. Dietrich, VIII-8-69, 3 ♂ (W. F. Barr, UID). *Owyhee Co.:* Sand Dune Lake, IX-9-63, 1 ♂ (W. F. Barr and G. B. Hewitt, UID). NEBRASKA: *Sioux Co.:* Glen Canyon, VIII-25-59, 2 ♀ (W. E. LaBerge and O. W. Isacson, NEB). NEW MEXICO: *Torrance Co.:* Town of Gran Quivira, 6500 ft., VIII-20-67, 1 ♂ (H. B. Leech, CAS). Duran, VII-13-59, 3 ♂ (E. G. Linsley, UCB). UTAH: Dixie State Park, VI-13-61, 1 ♂ (G. E. Bohart, OSU). *Millard Co.:* Flowell, VIII-20-61, 1 ♀ (G. E. Bohart, OSU). *Juab Co.:* 12 mi. s. Eureka, VII-18-58, 1 ♂ (J. W. MacSwain, UCB). *Washington Co.:* 1 mi. s. Toquerville, IX-5-79, 4 ♂, 1 ♀ (J. C. and E. M. Hall, UCR).

Variation.—Most of the major collections in the western United States and several national collections have been searched for additional specimens. Thirty-three specimens were found which I am unable to separate from the type series on morphological grounds, but they differ in coloration. The specimens from outside the type locality are less maculated than the type series. Pale markings are mostly whitish with some pale yellowish blotches. The four pale spots on the scutum tend to form longitudinal stripes, narrow to moderate in width. The mesopleuron and propodeum are pale spotted but not extensively so. The pale bands on terga III to V are biemarginate anteriorly. In the female the pale band on tergum I is interrupted medially, and the band on tergum II tends to enclose black spots laterally. Terga VI and VII are immaculate in the male.

A high degree of intraspecific color variation is well known in *Philanthus* and related genera from western North America, and several other species of *Philanthus* collected in Emery County, Utah, are among the more highly maculated specimens of the respective species. I therefore conclude that the type series and the other specimens are color variants of the same species.

Distribution.—From southern Idaho to northern Arizona west of the Rocky Mountains; and western Nebraska and central New Mexico east of the Rocky Mountains.

Flight period.—The type series was collected between August 19 and September 16 with August collections composed mostly of males and September collections composed mostly of females. The specimens not included in the type series were collected between August 8 and September 21, with the exception of one male collected in June (Utah) and three males collected in July (New Mexico). The species is apparently univoltine.

Etymology.—I am pleased to name this species for Dr. Frank D. Parker who sent me the first specimens collected with the suggestion that they might represent a new species.

Discussion.—The *politus* group and the monotypic *ventilabris* group of Bohart and Grissell (1975) have a metapleural lamella which is absent in other North American species groups. Elsewhere in the Philanthidae the metapleural lamella occurs only in the genera *Clypeadon* and *Listropygia* of the subfamily Aphilanthopinae (Bohart and Menke, 1976). The *politus* and *ventilabris* groups also have short, pale clypeal brushes in the males, and the inner margins of the lower eye lobes are parallel in both sexes.

In *P. ventilabris* the transversely grooved pronotal collar and contiguous coarse tergal punctures of both sexes, and the enlarged, flattened apical flagellomere of the male are autapomorphies, which I do not believe are sufficient in themselves to justify a group separate from the other species having a metapleural lamella.

Philanthus albopilosus Cresson was included in the *politus* group by Bohart and Grissell (1975), as it is here, but it too has certain unique characters. The thin head and wide vertex combined with an unusually wide interocellar distance are autapomorphies which serve to isolate the species from all others in the genus. The group relationship is based on the same shared characters mentioned above. In the key I have placed *P. ventilabris* and *P. albopilosus* in separate monotypic subgroups to indicate their more isolated positions.

The *politus* subgroup forms a compact, homogeneous group of five closely allied species. Of these, *P. politus, P. serrulatae* (= *P. siouxensis*), and *P. tarsatus* are separated from each other primarily on the basis of body sculpture and color characters, since the ocellocular proportions and head, face and vertex ratios are very similar in the three species.

P. psyche and *P. parkeri* n. sp. have a very short ocellocular distance, but they have arrived at this condition by two different routes. In males of *psyche* the maximum width of the head is 1.7 times the width of the face (measured at the apices of the eye emarginations), whereas this ratio is 1.5 in the other four species of the subgroup. The width of the face is 1.4 times the least vertex width in *psyche*—as it is in *politus* and *serrulatae.* This indicates that the higher head/face ratio in *psyche* is due to larger eyes relative to the other two species. The reduced malar space and reduced ocellocular distance in *psyche* have apparently resulted from this enlargement of the eyes.

In males of *parkeri* the head/face ratio is 1.5, as in *politus, serrulatae,* and *tarsatus*; but the face/vertex ratio has increased to 1.8 compared to 1.4 in *politus, serrulatae* and *psyche,* and 1.5 in *tarsatus.* The vertex has narrowed in *parkeri* with respect to the face, but the eyes have not perceptibly enlarged. The malar space remains, and both the interocellar and ocellocular distances have been reduced.

P. parkeri is presumed to be more closely related to *P. tarsatus* than to any other species in the subgroup because of the coarse punctures on the sterna of the two species. The denser sculpture of the upper face and ocellar area of the two species is shared with *P. politus* but not with *P. serrulatae* or *P. psyche.* In addition, the face/vertex ratio of *P. tarsatus* is 1.5, indicating a trend toward a narrowing of the vertex which reaches its culmination in the very narrow vertex of *P. parkeri.*

The narrow vertex and compact ocellocular area of *P. parkeri* are unique within the *politus* group and make it difficult to place in Bohart and Grissell's (1975) key. The following key is modified and adapted from their key to accommodate *P. parkeri.*

Key to Species of the *Philanthus politus* Group

1. Pronotal collar thick, shallowly, transversely grooved dorsally; interocellar distance less than ocellocular distance (*ventilabris* subgroup) . . . . *ventilabris* Fabricius
– Pronotal collar rounded, convex; interocellar distance equal to or greater than ocellocular distance 2
2. Head thin in side view, not swollen behind the eyes; interocellar distance greater than distance from lateral ocellus to posterior margin of head,

and greater than two lateral ocellus diameters (*albopilosus* subgroup) .... *albopilosus* Cresson
- Head swollen behind the eyes; interocellar distance about equal to or less than distance from lateral ocellus to posterior margin of head, and not greater than two lateral ocellus diameters (*politus* subgroup) 3

3. Males 4
- Females 8

4. Ocellocular distance about equal to lateral ocellus diameter and slightly less than midocellus diameter 5
- Ocellocular distance distinctly greater than lateral ocellus diameter and at least slightly greater than midocellus diameter 6

5. Malar space less than half the width of antennal pedicel; punctures of tergum II uniformly distributed and about same size as scutal punctures .... *psyche* Dunning
- Malar space at least ¾ the width of antennal pedicel; punctures of tergum II somewhat unevenly distributed, of uneven size, with numerous punctures smooth-rimmed and larger than scutal punctures .... *parkeri* Ferguson, new species

6. Upper face and area laterad of midocellus sparsely punctate with many large polished areas .... *serrulatae* Dunning
- Upper face densely punctured, interspersed with many fine ridges, sculpture extending into area laterad of midocellus 7

7. Hypoepimeron with dense, contiguous punctures and many microridges; pale band of tergum I broadly contiguous .... *tarsatus* H. Smith
- Hypoepimeron polished at least on anterior half, with scattered fine punctures; pale band of tergum I interrupted .... *politus* Say

8. Ocellocular distance about equal to diameter of midocellus; forewing costa whitish on basal half; conspicuous, recumbent, bristly pubescence on lower face between upper clypeal lobe and eye margin 9
- Ocellocular distance distinctly greater than diameter of midocellus; forewing costa reddish or brown to base; pubescence of lower face fine, not recumbent 10

9. Interocellar distance about twice the diameter of the lateral ocellus; sterna III-V sparsely, shallowly punctate; width of face at apices of eye emarginations 1.4 to 1.5 times least width of vertex ..... *psyche* Dunning
- Interocellar distance much less than twice the diameter of lateral ocellus; sterna III-V coarsely, rather densely punctate; width of face at apices of eye emarginations 1.7 to 1.8 times least width of vertex .... *parkeri* Ferguson, new species

10. Hindtarsi black or heavily infuscated; punctures of mesopleuron, especially hypoepimeron, dense, contiguous, with numerous microridges .... *tarsatus* H. Smith
- Hindtarsi yellowish to reddish; punctures of mesopleuron well separated by thick, polished ridges and anterior part of hypoepimeron shiny with sparse punctures 11

11. Hindfemora red, or black and red; scutal punctures sparse and irregular with numerous large polished areas .... *serrulatae* Dunning
- Hindfemora black and yellow; scutal punctures dense and evenly spaced at least over anterior ⅓ of scutum .... *politus* Say

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Heterotardigrada of Venezuela (Tardigrada)

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About 100 species of tardigrades are known from South America from the countries of Argentina, Bolivia, Brazil, Chile, Columbia, and Paraguay (Ramazzotti, 1972). In 1979 tardigrades were collected primarily in mosses and lichens from 10 sites in the northwestern section of Venezuela. The area collected represents only one-third of the country but over 20 species were identified in the class Eutardigrada and 14 in the Heterotardigrada. Only Brazil shows a larger species representation in the literature.

The Heterotardigrada found in Venezuela includes species in *Oreella, Mopsechiniscus, Bryodelphax, Echiniscus,* and *Pseudechiniscus.* Of the 14 species, five are new—one species each of *Oreella* and *Bryodelphax,* and three species of *Echiniscus* in the arctomys complex. Holotypes are deposited at the University of California, Davis, and voucher specimens at the University of Zulia, Maracaibo.

MATERIALS AND METHODS

Mosses, lichens, and liverworts were removed from various plant and mineral substrates, placed in paper bags, and air dried—at times with artificial heat. Specimens were processed in the United States and prepared for light microscopy and scanning electron microscopy as indicated in Horning, Schuster and Grigarick (1978). One or more species of Heterotardigrada were collected from the following sites:

El Tucuco, Zulia. VI-24-79. Tropical forest in foothills of Sierra De Perija, bordering a grassland biome, alt. 700 m, precipitation 2000 mm.

La Carbonera, Merida. VI-30-79. Subtropical cloud forest in Sierra Nevada range of Andes, alt. 2000 m, precipitation 1800 mm.

Merida, Merida. VII-3-79. Sierra Nevada range of Andes, alt. 1627 m, precipitation 1800 mm.

La Mucuy, Merida. VII-4-79. Sierra De St. Domingo range of Andes, alt. 1800 m, precipitation 1800 mm.

Barrancas, Barinas. VII-6-79. Foothills of Sierra De St. Domingo range and edge of Llanos Planes, alt. 200 m, precipitation 1280 mm.

Yacambu, Lara. VII-9-79. Subtropical rainforest, alt. 1500 m, precipitation 1300 mm.

Rancho Grande, Aragua. VII-14-79. Tropical rainforest, alt. 1130 m, precipitation 1720 mm.

Tardigrades in the class Heterogardigrada are recognized by the presence of a lateral clava and cirrus between the head and scapular segments. Both families, Echiniscidae and Oreellidae, of the Order Echiniscoidea occur in Venezuela.

The Echiniscidae typically have five transverse segments, designated by letters A through E, also referred to as the head (A), scapular (B) and terminal (E) segments. Median plates are numbered from anterior to posterior. Lateral spines occur at the post-lateral angles of the transverse segments and bear the same letter. Dorsal spines are identified by the segment letter and superscript "d." *Pseudechiniscus* has an additional segment (pseudosegmental plate) between segments D and E. The following keys will distinguish the taxa found in this study.

Key to Families and Genera

1. Dorsum without distinct plates .... Oreellidae—*Oreella*
– Dorsum with distinct plates .... Echiniscidae—2
2. Head without buccal cirri .... *Mopsechiniscus*
– Head with buccal cirri 3
3. Pseudosegmental plate present .... *Pseudechiniscus*
– Pseudosegmental plate absent 4
4. Median plates 1 and 2 transversely divided .... *Bryodelphax*
– Median plates 1 and 2 not divided .... *Echiniscus*

Key to *Pseudechiniscus*

1. Posterior margin of pseudosegmental plate with two spines or lobes; granulation large (0.7–1.25 μm); cuticle without pores ....
.... *P. novaezeelandiae* (Richters)
– Posterior margin of pseudosegmental plate without spines or lobes; granulation small (0.5–0.8 μm); cuticle with pores . . *P. suillus facettalis* Peterson

Key to *Echiniscus*

1. Lateral spines present only on plate A (cirrus A) 2
– Lateral spines present on plate A and one or more other plates 6
2. Cuticle not green 3
– Cuticle green 5
3. Cuticle of dorsal plates consists of pores (light spots) and granules (dark spots); spines smooth 4
– Cuticle of dorsal plates consists of pores only; E spines barbed dorsally and sometimes ventrally .... *E. angolensis* da Cunha and Ribeiro
4. Some dorsal or lateral spines as long as spine E; legs II and III without minute spine .... *E. virginicus* Riggin
– Dorsal and/or lateral spines shorter than spine E; legs II and III with minute spines .... *E. perarmatus* Murray
5. Cuticle of dorsal plates with pores .... *E. viridissimus* Péterfi
– Cuticle of dorsal plates without pores .... *E. viridus* Murray
6. Cuticle of dorsal plates with pores (light spots only) 7
– Cuticle of dorsal plates with pores (light spots) and granules (dark spots)
.... 8
7. Scapular and terminal plates with longitudinal and transverse bands lacking pores .... *E. kofordi* Schuster and Grigarick
– Scapular and terminal plates without such bands ....
.... *E. mosaicus* Grigarick, Schuster, and Nelson, n. sp.
8. Cuticle of dorsal plates with regularly distributed pores; anterior margins

of plates C and D with pores ....
.... *E. aliquantillus* Grigarick, Schuster, and Nelson, n. sp.
– Cuticle of dorsal plates with irregularly distributed pores; anterior margins of plates C and D without pores ....
.... *E. marginoporus* Grigarick, Schuster, and Nelson, n. sp.

Genus *Oreella* Murray, 1910

The genus *Oreella* is in the family Oreellidae. It is distinguished from the other genera in the family, which are aquatic, by its indistinctly eight-segmented body lacking dorsal plates and by the presence of a short median caudal projection. According to the diagnostic characters of the genus (Ramazzotti, 1972:136), the claws are not spurred; however, the inner claws of the New Zealand specimens (Horning *et al.,* 1978) of *Oreella minor* Ramazzotti do have spurs, as does the single specimen of *Oreella* from Venezuela.

Oreella breviclava Grigarick, Schuster, and Nelson, New Species
(Figs. 1, 2)

Holotype female.—Length excluding legs IV, 174 μm; including legs IV, 191 μm; width, 81 μm. No eyes. Cuticle colorless, with very fine granulation over entire surface; small hemisphericle tubercles visible along margins of cuticle, present on dorsal and lateral cuticle; short, median, conical, caudal papilla between legs IV. Head with acuminate buccal cirri; internal cirrus 10 μm long; external cirrus, 14 μm long; buccal papilla 5.7 μm long by 2 μm wide. Cirrus A, 19 μm long; clava short, 5 μm long by 2 μm wide. Leg I apparently without spine; papilla on leg IV 2 μm long by 1 μm wide; without dentate fringe on legs IV. Strong spurs on internal claws of all legs; claws 10 μm long.

Etymology.—Latin: *brevi,* short; *clava,* for the short clava.

Discussion.—A single specimen was collected from one locality in Venezuela. It is very similar to *Oreella minor* but differs in the following respects: relative lengths of the internal and external cirri, the presence of buccal papillae, claw length, the absence of a spine on leg I, and the length of the clava. The internal cirrus is half the length of the external in *O. minor,* but greater than half the length (2/3) in the Venezuelan specimen. In his illustration of *O. minor* from Chile, Ramazzotti (1964) omitted the buccal papillae because he was unable to detect them on the eight specimens he studied; our specimen has distinct buccal papillae. The claws of *O. minor* are smaller (3–4 μm) than those of our specimen (10 μm). An obvious spine is present on leg I of *O. minor*; no such spine is apparent on our specimen. Ramazzotti (1972) suggested that specimens with long, more or less curved clavae (11–18 μm) are probably males of *O. minor,* while those with short straight clavae (3.5–5 μm) are females, corresponding to the hypothesis for *Halechiniscus* proposed by Richters (1909) and Schulz (1955). The specimen from Venezuela is a female based on the structure of the gonopore, and therefore may actually be *O. minor* if Ramazzotti's hypothesis is correct.

Another species, *Oreella vilucensis* Rahm, was described from Chile. This species is characterized by the presence of two lateral conical spines and the absence of clavae, which, if correct, would be unique in the Echiniscoidea.

A third species, *Oreella mollis* Murray, is a larger species that has a long thin clava, very long cirri A, no fine granulation (although it may have been overlooked), marked body segmentation, and internal claws without spurs.

Distribution.—Holotype, La Carbonera, 1 specimen.

Genus *Mopsechiniscus* du Bois-Reymond Marcus, 1944

The genus *Mopsechiniscus* in the family Echiniscidae is characterized by the absence of the buccal cirri and the presence of two lateral oval cephalic structures and a small median process dorsal to the buccal aperture. Two species have been reported from South America: *Mopsechiniscus imberbis* (Richters) from Chile and Brazil; *Mopsechiniscus granulosus* Mihelčič from the Andes in Argentina.

Mopsechiniscus imberbis (Richters), 1907
(Figs. 3–5)

Our specimens illustrate a wide range of variability in the presence and lengths of the spines and filaments. Ramazzotti (1972) reported variations found in three populations of *M. imberbis,* from South Georgia, Brazil and Chile. The South Georgia specimens have lateral C spines and D filaments; the Brazilian, with C spines only (sometimes missing); and the Chilean, with lateral C and D filaments and sometimes small B spines. Our specimens have a combination of no spines; lateral spines at D only or C and D; short lateral spines at C and D and a strong spine at the posterior margin of the pseudosegmental plate; or strong or short spines only on the pseudosegmental plate. A single larva has dorsal spines at the posterior margins of median plates 1 and 2 and the pseudosegmental plate. In general, the number and length of the spines decrease with an increase in the body length of the animal. The opposite situation occurs in other armored tardigrades such as *Echiniscus* and *Pseudechiniscus.* Our specimens also have spurs at the base of the inner claws on all legs, but they are much less developed on legs I–III. The cuticle is ornamented with irregular-sized raised dark granules.

The cuticle of *Mopsechiniscus granulosus* is ornamented, according to Mihelčič (1967), *inside* the cuticle itself, not on the surface. There are short B spines, long lateral C and D filaments, and the caudal margin of the pseudosegmental plate has two lobes bearing a distal spine.

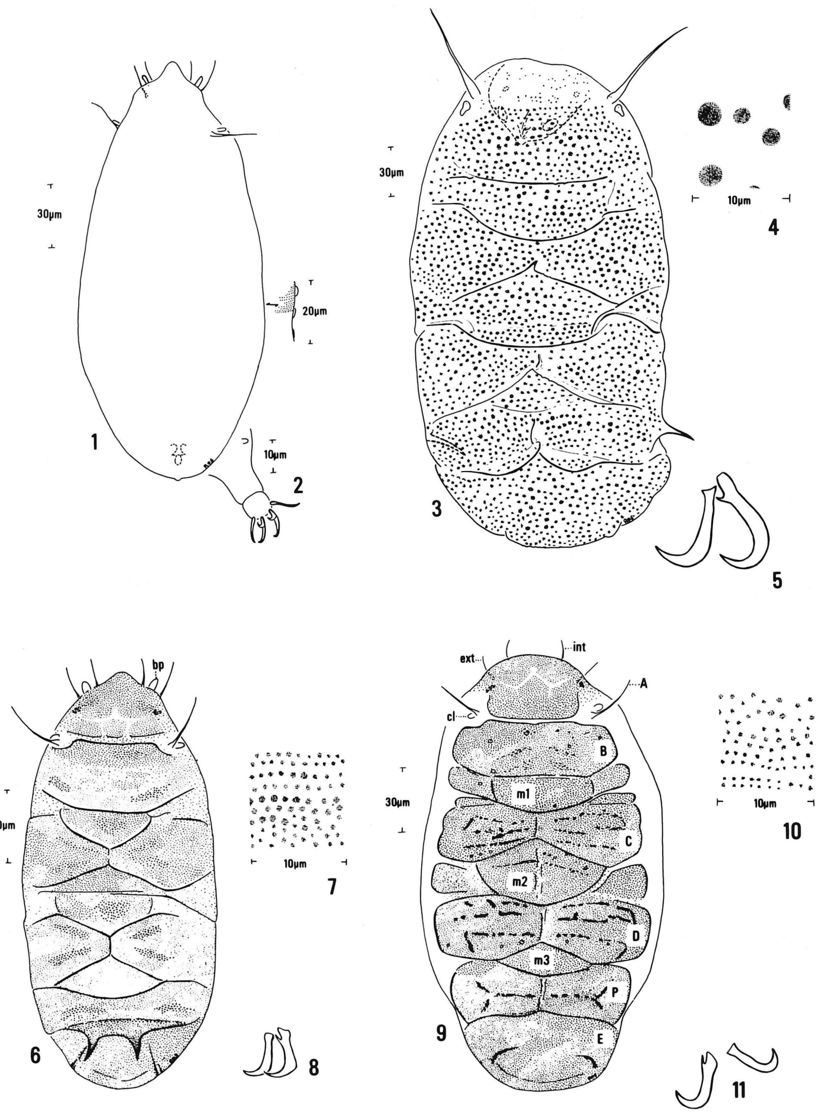
Distribution.—La Carbonera, 5 specimens; Merida, 1.

Genus *Pseudechiniscus* Thulin, 1911

The genus *Pseudechiniscus* in the family Echiniscidae is characterized by the presence of a transverse pseudosegmental plate between the second paired plates (D) and the terminal plate. Six species have been reported from South America from Chile, Bolivia, Argentina, Brazil, and Columbia. The two species collected in Venezuela were recovered from samples at four of the seven areas heterotardigrades were found. Most of the collections were made in the higher mountainous areas of the Andes.

Pseudechiniscus novaezeelandiae (Richters), 1908
(Figs. 6–8)

Our specimens agree with the description in Ramazzotti's monograph (1972), and with specimens from New Zealand in our collection. The cuticular granulation



Figs. 1–11. 1, 2. *Oreella breviclava.* 1, dorsal aspect; 2, detail of legs and claws IV. 3–5. *Mopsechiniscus imberbis.* 3, dorsal aspect; 4, cuticle of scapular plate; 5, exterior and interior claws leg IV. 6–8. *Pseudechiniscus novaezeelandiae.* 6, dorsal aspect; 7, cuticle of scapular plate; 8, exterior and interior claws leg IV. 9–11. *Pseudechiniscus suillus facettalis.* 9, dorsal aspect; 10, cuticle of scapular plate; 11, exterior and interior claws leg IV.

is coarser than on *Pseudechiniscus s. facettalis.* The granules are larger on the interior margin of the scapular plate, median plates 1 and 2 and the anterior halves of the paired plates. Two spines, variable in size, are usually, but not always, present on the posterior margin of the pseudosegmental plate. A thin basal spur is present on the inner claw of all legs.

Discussion.—*Pseudechiniscus n. novaezeelandiae* has been previously reported in South America from Brazil, Columbia and Argentina. It is difficult to distinguish from the subspecies *P. n. marinae* Barros and *P. pseudoconifer* Ramazzotti and according to Ramazzotti (1972), the specimens from Brazil identified as *P. n. marinae* by Barros were probably *P. pseudoconifer.* The cuticular granule size and absence of cuticular pores are useful in separating *P. n. novaezeelandiae* from *P. s. facettalis.*

Distribution.—La Mucuy, 26 specimens; Merida, 13; Barrancas, 1; La Carbonera, 5.

Pseudechiniscus suillus facettalis Petersen, 1951
(Figs. 9–11)

Our specimens agree with the description in Ramazzotti's monograph (1972). The terminal plate is faceted, and there is a tiny spur at the base of the inner claws on all legs. The cuticle has a fine granulation with ridged areas of thickened cuticle; a few pores are scattered irregularly in the cuticle.

Discussion.—The *suillus* group includes *Pseudechiniscus suillus facettalis* Petersen and *Pseudechiniscus suillus franciscae* Barros. The nominate subspecies is known from five South American countries. The subspecies *P. s. facettalis* has been reported from Tierra del Fuego (Ramazzotti, 1972). Originally described from Brazil, *P. s. franciscae* differs from our specimens by the presence of smooth cuticle between the plates and the absence of spurs on all claws. A similar species, *Pseudechiniscus juanitae* Barros, also described from Brazil, has "large" granules, especially on the pseudosegmental plate and the terminal plate (Barros, 1939).

Distribution.—La Mucuy, 31 specimens; Merida, 39; Barrancas, 1; La Carbonera, 6.

Genus *Bryodelphax* Thulin, 1928

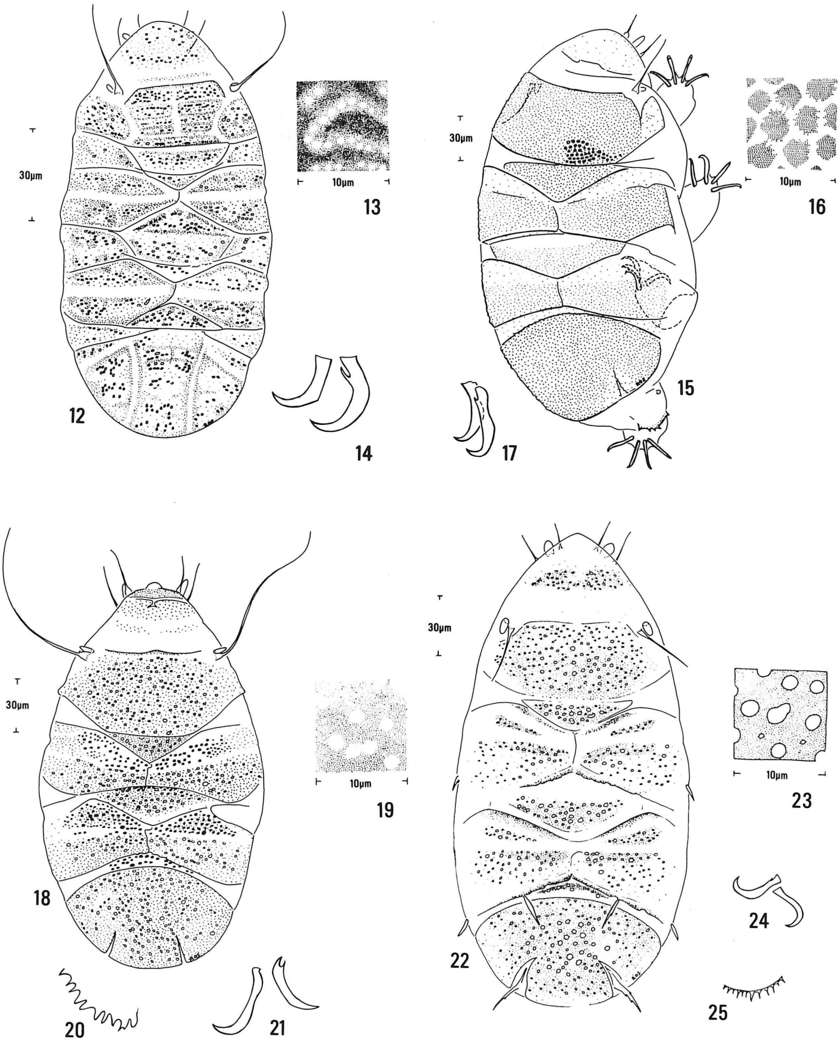
The genus *Bryodelphax* is in the family Echiniscidae. *Bryodelphax* is distinguished from other genera in the family by the transverse division of the first and second median plates with the third median plate undivided and highly developed; in addition, the terminal plate lacks the two notches along the posterior margin.

Bryodelphax crossotus Grigarick, Schuster, and Nelson, New Species
(Figs. 12–14)

Holotype female.—Length excluding legs IV, 135 μm. Cuticle colorless, with granulation and pores on all plates, forming indistinct ridges on scapular and terminal plates. Median plates 1 and 2 divided, median plate 3 undivided, triangular in shape. Head with acuminate buccal cirri internal cirrus 5 μm long, external cirrus, 10 μm long; buccal papilla 2 μm long by 1.9 μm wide. Cirrus A, 30 μm long; clava, 2.5 μm long by 1.9 μm wide. No apparent spine on leg I; papilla on leg IV, 4.8 μm long by 2.8 μm wide; non-dentate fringe on leg IV, thickened irregular, almost scalloped edge, granulate above. Claws 8 μm long; inner claws with spurs at base on all legs; all legs microgranulate.

Etymology.—Greek: *krossotus,* fringed, for the non-dentate fringe on legs IV.

Discussion.—*Bryodelphax ortholineatus* Bartos, *B. parvulus* Thulin and *B. dominicanus* Schuster & Toftner are species from South or Central America that have the dorsal collar of leg IV with a smooth distal margin. This margin is somewhat irregular on *B. crossotus* but not dentate. The cuticles of *ortholineatus*



Figs. 12–25. 12–14. *Bryodelphax crossotus.* 12, dorsal aspect; 13, cuticle of scapular plate; 14, claws of leg IV. 15–17. *Echiniscus viridis.* 15, dorsal aspect; 16, cuticle of scapular plate; 17, claws leg IV. 18–21. *Echiniscus viridissimus.* 18, dorsal aspect; 19, cuticle of scapular plate; 20, dorsal denticles leg IV; 21, claws leg IV. 22–25. *Echiniscus augolensis.* 22, dorsal aspect; 23, cuticle of scapular plate; 24, claws leg IV; 25, dorsal denticles leg IV.

and *parvulus* and the shape of the median plates are different from *crossotus.* This species is similar to *dominicanus* but the cuticle does not have the large depressions (fossae) of *dominicanus.*

Distribution.—Holotype, Rancho Grande; paratypes: El Tucuco, 13 specimens; Rancho Grande, 1.

Genus *Echiniscus* C. A. S. Schultze, 1840

The genus *Echiniscus* is in the family Echiniscidae Thulin, 1928. *Echiniscus* is distinguished from the other genera by undivided median plates 1, 2, and 3, and by the presence of notches along the posterior margin of the terminal plate. In Ramazzotti's key (1972), species of *Echiniscus* are grouped according to Marcus: the groups *arctomys, spinulosus, scrofa, blumi, trisetosus,* and *biunguis.* The *arctomys* group consists of the species of *Echiniscus* that have no lateral appendages other than cirrus A, although dorsal appendages may be present. The other groups are distinguished by the number and type (spine, filament) of lateral appendages. Nine species of *Echiniscus* were collected in Venezuela, three of which are new species in the *arctomys* group.

Echiniscus viridis Murray, 1910
(Figs. 15–17)

Our specimen fits the description in Ramazzotti's monograph (1972). Cirrus A is 38 μm long. The cuticle is green and ornamented with clusters of small dark green granules which form slight tubercles which appear as dark spots. A minute basal spur is present on the inner claws of all legs. The dentate fringe has short uneven spines with very irregular spacing in between the spines; the arrangement of these dorsal leg spines is very distinctive and unique in the species complex.

Discussion.—*Echiniscus viridis,* known from Brazil, is one of four described species in the *viridis* complex. The complex consists of green *Echiniscus* with no lateral or dorsal appendages other than cirrus A. *Echiniscus perviridis* Ramazzotti has a pattern of raised granules similar to that of *E. viridis*; however cirri A are up to 150–170 μm long. *Echiniscus rufoviridis* Bois-Reymond Marcus, described from Brazil, is green caudally only, with short cirri A (30–40 μm). The cuticular pattern of *Echiniscus viridissimus* Pêterfi consists of both pores and dark raised granules. The cuticle of *E. viridis* is pigmented in areas indicated by denser stippling (Fig. 15) and the dorsal plates, except for the head, show a rather uniform pattern of discrete granules.

Distribution.—Rancho Grande, 1 specimen.

Echiniscus viridissimus Pêterfi, 1956
(Figs. 18–21)

Our specimens fit the description of Ramazzotti's monograph and agree with determined specimens in the collections at ETSU and UCD. Cirrus A is 75 μm long. The cuticle is green and ornamented with a very fine regular granulation. The scapular and terminal plates have pores, which appear as light spots. The paired plates have an anterior zone of dark granules which appear separated from the posterior zone by a transverse stripe.

Discussion.—The dorsal plating of this species is greenish in the same areas as *E. viridis.* Whereas the cuticular pattern of the dorsal plates of *E. viridis* consists of discrete granules, that of *E. viridissimus* is predominantly of pores (light spots) except for a minutely granular head and granules on the anterior of plate pairs C and D and on the area between plates D and the terminal plate.

Distribution.—Rancho Grande, 11 specimens.

Echiniscus angolensis da Cunha and Ribeiro, 1964
(Figs. 22–25)

Body length excluding legs IV, 225 μm. Cuticle with pores only, slightly larger on median plates. Cephalic plate with rostral zone of pores. Cirrus A, 29 μm long.

Short C, D spines (5–6 μm); robust D^d spine, 17 μm, may have rough or spiny appearance; robust, rough (spiny) E spine, 16 μm. Terminal plate with distinct notches. Dentate fringe on legs IV with 16–17 slender, sharp, short teeth. Very slender spur on internal claws of all legs.

Discussion.—The distinction between *Echiniscus angolensis* from West Africa and *Echiniscus crassispinosus fasciatus* Marcus from Brazil and East Africa is difficult. Based on the illustrations in Ramazzotti's monograph (1972), the Venezuelan specimens more closely resemble *E. angolensis,* although there are some discrepancies not yet resolved. The description of *E. angolensis* does not mention the presence of the C spine, yet it is clearly illustrated in their drawing; the C^d spine which is mentioned is very small or missing on the illustration.

We have not seen the type of either species and have elected to use the name *E. angolensis* at this time.

Distribution.—Merida, 4 specimens.

***Echiniscus virginicus* Riggin, 1962**
(Figs. 26–29)

Cuticle with characteristic ornamentation of pores and granules. Area of median plate 3 also ornamented. Posterior margins of paired plates minutely scalloped. The dorsal and lateral spines are variable, both in occurrence and development. Lateral spine B is sometimes absent on one or both sides; C, D, E are present. Dorsal spines C^d and D^d are of variable length and rarely absent; the spines may be the same length or either may be considerably shorter than the other. Spur present at base of internal claws of all legs. Leg I with spine and leg IV with large papilla. Dentate fringe with 8–10 teeth.

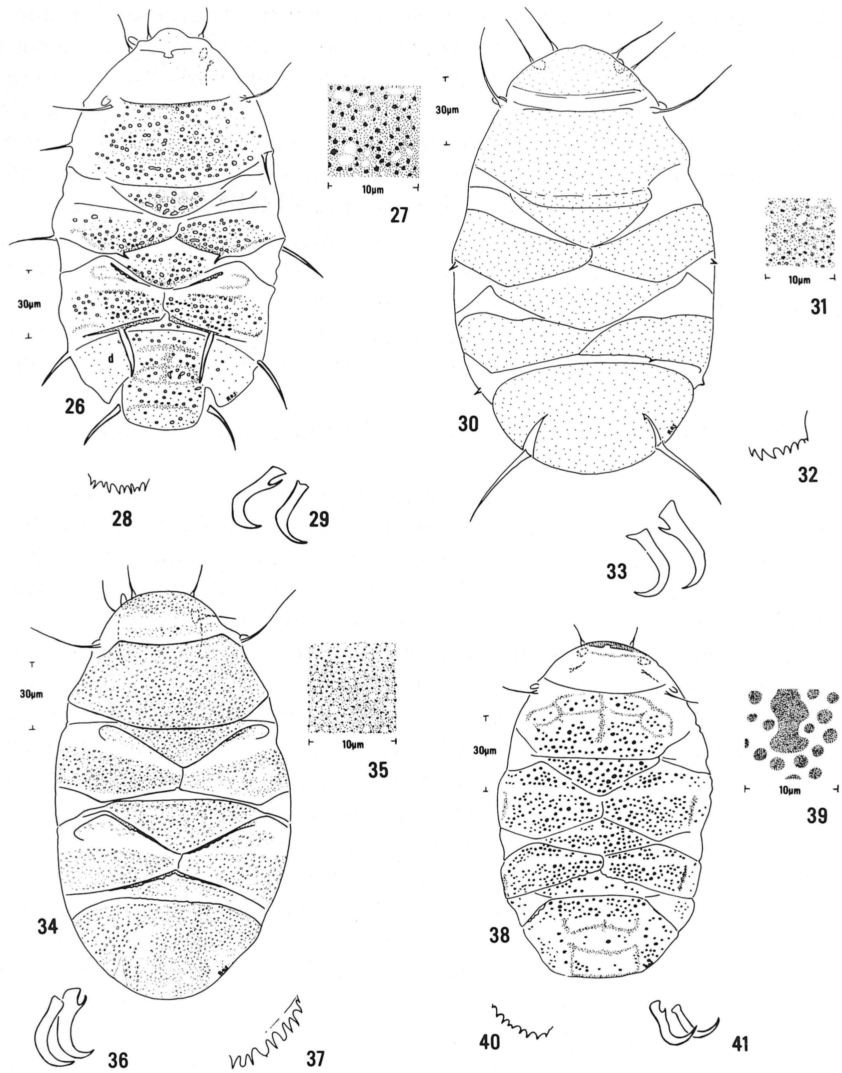
Discussion.—The Venezuelan specimens agree with Riggin's holotype deposited in the Smithsonian Institution and with other specimens from Florida and Tennessee. The cuticular ornamentation differs from that of *Echiniscus quadrispinosus brachyspinosus* Bartos, which Ramazzotti considered the same as *E. virginicus.*

Distribution.—La Carbonera, 9 specimens; La Mucuy, 15; Merida, 19; Barrancas, 4; El Tucuco, 1; Yacambu, 5; Rancho Grande, 2. *Echiniscus virginicus* was the most widely distributed heterotardigrade and was only surpassed by *Pseudechiniscus suillus facettalis* in numbers collected.

***Echiniscus perarmatus* Murray, 1907**
(Figs. 30–33)

The Venezuelan specimens agree with the description in Ramazzotti's monograph (1972). The cuticle is ornamented with a very fine uniform granulation, larger regularly distributed granules, and a few light pores. Each pore appears bordered by four of the larger granules. Although pores are not mentioned in the original description, they are present as surface structures. Short C, D teeth are present and occasionally very short D^d spines. The E spines are curved and as long or longer than cirrus A. A distinguishing character is the presence of a short thorn-like papilla on legs I–III; legs II and III should be observed carefully.

Discussion.—The species was described from South Africa and another report from Hawaii is uncertain. Dr. Deidre Christenberry has collected *E. perarmatus* from the Southeastern United States. Her specimens, deposited at the Smithsonian Institution, agree closely with ours.



Figs. 26–41. 26–29. *Echiniscus virginicus.* 26, dorsal aspect; 27, cuticle of scapular plate; 28, dorsal denticles of leg IV; 29, internal and external claws leg IV. 30–33. *Echiniscus perarmatus.* 30, dorsal aspect; 31, cuticle of scapular plate; 32, dorsal denticles of leg IV; 33, internal and external claws leg IV. 34–37. *Echiniscus aliquantillus.* 34, dorsal aspect; 35, cuticle of scapular plate; 36, internal and external claws leg IV; 37, dorsal denticles leg IV. 38–41. *Echiniscus kofordi.* 38, dorsal aspect; 39, cuticle of scapular plate; 40, dorsal denticles of leg IV; 41, internal and external claws leg IV.

Distribution.—Yacambu, 10 specimens.

Echiniscus aliquantillus **Grigarick, Schuster, and Nelson, New Species**
(Figs. 34–37)

Holotype female.—Length excluding legs IV, 185 μm. Cuticle colorless; all plates with very fine regular granulation and random distribution of small but distinct pores. Cephalic plate with rostral zone of pores and granules and posterior band of very fine granulation and very small pores. Pattern of granulation and pores similar on median plates 1 and 2; median plate 3 absent or not well-defined but the area between the paired plates and the terminal plate has the same cuticular pattern as the other median plates. Paired plates have clear zone separating the anterior (with few pores) from the posterior part. Granulation and pores extend onto legs. Posterior margin of median plate 2 and paired plates D is scalloped. Head with acuminate buccal cirri; internal cirrus 14 μm long; external cirrus, 16 μm long; buccal papilla, 7 μm long by 3 μm wide. Cirrus A, 34 μm long; clava, 7.6 μm long by 2.4 μm wide, longer and thinner than buccal papilla. Slender spine on leg I; papilla on leg IV 5 μm long by 2 μm wide. Dentate fringe on leg IV with 10–12 short sharp spines; area above fringe with pores and granules. Spurs on internal claws of all legs, very distinct and well-developed on legs IV; claws 12 μm.

Etymology.—Latin: *aliquantillus,* very small; named for the numerous small pores.

Discussion.—Several species in the arctomys group are very similar but can be distinguished by their cuticular patterns. Previously named species differ from the Venezuelan specimens in the following ways. *Echiniscus arctomys* Ehrenberg and *Echiniscus wendti* Richters, both reported from South America, have granulations but no pores; both have longer cirri A, especially *E. wendti* which has a cirrus A length up to 55–70% of the body length. *Echiniscus phocae* Bois-Reymond Marcus, described from Brazil, has a characteristic ornamentation consisting of circular groups of small granules. Mihelčič (1967) described several similar species from Argentina, including *Echiniscus bellus, insuetus, roseus,* and *speciosus*; these species are practically indistinguishable on the basis of their descriptions, and slides identified and labeled by Mihelčič do not correspond to each other or the descriptions. All have cirrus A much longer than in the Venezuelan specimens.

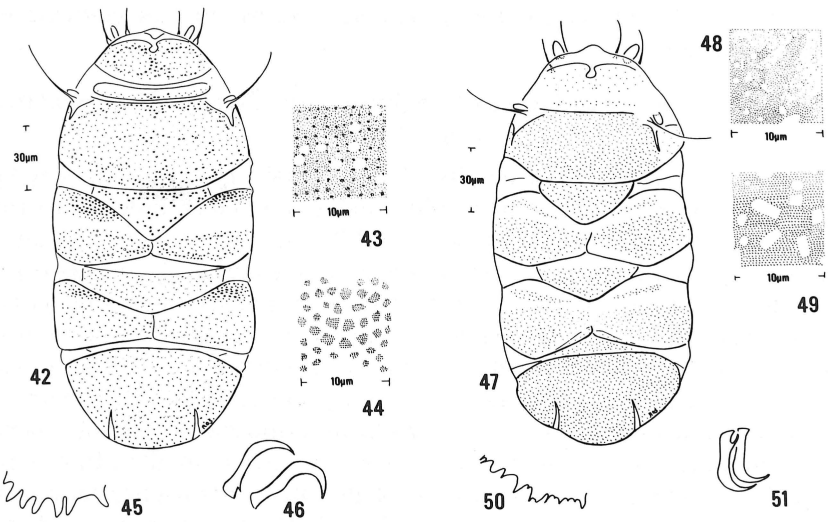
The cuticular pattern of *Echiniscus kerguelensis* Richters, reported from Australia and SW Africa at 1600–2000 m and other localities, most clearly resembles that of the Venezuelan specimens. The description in Ramazzotti (1972), however, is unclear and may represent a combination of two or more species. For example, the ornamentation can appear granulated or porous; the two paired plates have, or do not have, a smooth unornamented transverse stripe; lateral cirrus A is 50–80 μm; claws, 18 μm long. The Venezuelan specimens have very fine granulation and pores, an unornamented stripe on the paired plates, shorter cirrus A, and shorter claws.

Distribution.—Holotype, La Carbonera; paratypes: La Carbonera, 36 specimens; Merida, 4.

Echiniscus kofordi Schuster and Grigarick, 1966
(Figs. 38–41)

This species has only lateral cirrus A. The dorsal plates are granular with distinctive patterns (fine stipple on Fig. 38) on the head, scapular and terminal plates, and lateral margins of C and D.

Discussion.—This species is related to *E. tesselatus* J. Murray but differs by having a shorter spine A and by the divisions of the scapular and terminal plates. The single specimen compared favorably with the type from the Galápagos Islands.



Figs. 42–51. 42–46. *Echiniscus marginoporus.* 42, dorsal aspect; 43, cuticle of scapular plate; 44, cuticle of anterior margins of plates C and D; 45, dorsal denticles of leg IV; 46, internal and external claws leg IV. 47–51. *Echiniscus mosaicus.* 47, dorsal aspect; 48, 49, variation in pores of cuticle of scapular plate; 50, dorsal denticles of leg IV; 51, internal and external claws leg IV.

Distribution.—El Tucuco, 1 specimen.

Echiniscus marginoporus **Grigarick, Schuster, and Nelson, NEW SPECIES**
(Figs. 42–46)

Holotype female.—Length excluding legs IV, 200 µm. Cuticle colorless; cuticular pattern consists of granulation and pores. Cephalic plate consists of a rostral zone with regular granulation and a few small pores, separated by a clear zone from a posterior band of granules and pores. Scapular plate with regular granulation and marginal pores (Fig. 43), especially on posterior part, and irregular median row of pores. Anterior portion of plates C and D with irregular shaped granules only (no pores) and posterior portion with granules and marginal pores, especially along posterior margin. Paired plates entirely granulated, no unornamented stripe present. Median plates 1 and 2 with regular granules and pores; median 3 absent but area between D and E plates with granules. Terminal plates with granules and scattered small pores. Head with internal acuminate buccal cirrus 12 µm; external cirrus, 18 µm; buccal papilla 6.6 µm long by 2.8 µm wide. Spine on leg I a small thorn; papilla on leg IV present. Dentate fringe on leg IV with 7–8 well-defined large sharp teeth; area above fringe granulated. Dorsal surface of all legs granulate; internal claws of all legs with spurs, internal claws, 16 µm; external claws, 14 µm.

Etymology.—Latin: *marginoporus* was named for the marginal pores on the plates.

Discussion.—The Venezuelan specimens are in the arctomys group, but the cuticular pattern differs from all other described species. See also the discussion of *Echiniscus aliquantillus* n. sp.

Distribution.—Holotype, La Mucuy; paratypes: La Mucuy, 2 specimens; Rancho Grande, 1; Barrancas, 2.

***Echiniscus mosaicus* Grigarick, Schuster, and Nelson, New Species**
(Figs. 47–51)

Holotype female.—Length excluding legs IV, 190 μm; including legs IV, 218 μm. Cuticle colorless. Cephalic plate with small pores and granules on rostral zone of head. Scapular plate with large pores 1–2.8 μm, and large black granules 2–3 μm; 4–6 pores surround granule, larger on posterior margin (Figs. 48–49). Paired plates with clear (unornamented) transverse stripe that separates smaller anterior part from posterior portion of plate. Median plates 1 and 2 with pattern similar to posterior margin of scapular plate. Median 3 small but area has pattern similar to other median plates. Terminal plate with pronounced pores. Interpore area triangular or hexagonal. Cuticular pattern forms a mosaic appearance; hexagonal pattern is more apparent in some areas where pore size is smaller. Interpore areas are joined, forming a reticulate pattern. Slight lateral hemispherical pouch may be seen on some specimens between legs II and III and between legs III and IV. Head with acuminate buccal cirri, internal cirrus, 15 μm long; external cirrus, 19 μm long; buccal papilla prominent, 9.5 μm long by 5.7 μm wide, larger than clava. Cirrus A, 33 μm; clava, 7.6 μm long by 3.8 μm wide. Spine on leg I a short thorn; papilla on leg IV 3.8 μm long by 2 μm wide. Dentate fringe on leg IV with 10–12 sharp spines of irregular size. Spurs on internal claws of all legs; internal claws, 14 μm; external claws, 13 μm.

Etymology.—Latin: *mosaicus,* mosaic; named for the mosaic cuticular pattern.

Discussion.—The cuticular pattern of *E. mosaicus* somewhat resembles that of *Echiniscus elegans* Richters and *Echiniscus reticulatus* Murray, and is reminiscent of the gameboard for Chinese checkers. The smaller sized cuticular pattern and transverse clear stripes on the paired plates of *E. mosaicus* readily distinguish it from these species.

Distribution.—Holotype, La Carbonera; paratype, Merida, 1 specimen.

Acknowledgments

We wish to thank Dr. Richard Bohart for partially financing and initiating the arrangements that led to the collections of tardigrades reported in this paper. The arrangements were made with Dr. Edmundo Rubio, the Dean of the Faculty of Agronomy of the University of Zulia and formerly a student of Dr. Bohart. Financing and assistance within Venezuela were provided by the University of Zulia. Mr. Guillermo Alvarado Duran and many of the University staff were of great help during the collecting trips. Facilities were also provided by the University of Los Andes and the University of Central Venezuela at Maracay. Mr. Robert Brooks and Mr. John McLaughlin (UCD) assisted with the tardigrade collections and Mr. Chris Williams (ETSU) helped with the sorting.

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Boharticus, N. Gen., with a Review of *Rhopalicus* Foerster and *Dinotiscus* Ghesquiere (Hymenoptera: Pteromalidae)

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This paper represents a preliminary step toward integrating knowledge of the Nearctic and Palearctic faunas of Pteromalidae. It presents a review of the known species of *Rhopalicus* Foerster and *Dinotiscus* Ghesquiere, in which a new Nearctic species of *Rhopalicus* is described (*zolae*), the Palearctic species *Dinotiscus aponius* is reported for the first time from the Nearctic, two Nearctic species of *Dinotiscus* (*acutus, polygraphi*) are synonymized under a Palearctic name (*D. eupterus*), the Nearctic species *D. burkei* is synonymized with *D. dendroctoni,* and keys to the 11 known species of both genera are given. All species are associated with wood-infesting beetles. Additionally, the new genus *Boharticus* is described for 4 new species associated with Cecidomyiidae on *Juniperus.*

The findings of this paper are based upon a comparison of type-specimens and identified material from both the British Museum (Natural History) (hereafter BMNH) and the United States National Museum (USNM). Additional material was borrowed from the Florida State Collection of Arthropods (FSCA), Gainesville, Florida. Host records are mainly from Burks (1979) and Graham (1969), but nomenclatural changes for these records have been made based upon newly published references (Wood, 1982; O'Brien and Wibmer, 1982). In the case of generic synonymy, I have relied upon the taxonomic conclusions reached by Graham (1969) who, for many years, has studied the types of European Pteromalidae. His research furnishes a base for much future pteromalid work.

Many years ago, when I began my chalcidoid studies, I desperately needed a starting point such as that provided by Graham (1969). By taking up a group wherein scarcely anyone was working, I assured myself of one thing . . . no help whatsoever! At least it seemed that way at the time. But upon the deliberations of numerous passing years, I now realize that I really did have one resource of help and a steady one at that. It was the source of direction, of purpose, and of inspiration that came from Dick Bohart, an entomologist's entomologist. Without "Doc" there somewhere, always willing to help, I should surely have stumbled once too often. Dick and his wife, Margaret, were generous to me in particular, and to their students in general. I take great satisfaction in dedicating this work to both of them.

PTEROMALID CLASSIFICATION

Before presenting the descriptive aspects of this paper, a few general comments should be made about the state of our knowledge of pteromalid taxonomy. Current world figures place the number of valid pteromalid species at 3111 and the number of genera at 611 (J. S. Noyes, pers. comm.). In the Nearctic there are nearly 400 species in 129 genera (Burks, 1979). These figures are misleadingly low if we consider the potential number of undescribed taxa and the fact that the group has been poorly collected and studied.

In the Nearctic there has been little revisionary work which would serve as a basis for the study of pteromalid taxonomy. In the Palearctic, however, Graham (1969) published a monograph of the Pteromalidae of northwestern Europe in which he provided keys to all European genera. Comparison of Graham's work with the most recent Nearctic catalog (Burks, 1979) shows that over two-thirds (ca. 80 of 110) of the genera treated by Graham are Holarctic. Therefore Graham's work could serve an important function in first helping us to understand the Nearctic fauna, and more importantly, in providing a starting point for the integration of the Nearctic and Palearctic faunas.

As important as Graham's work is, however, its indiscriminate use may cause problems. The description of the new genus *Boharticus* has highlighted some of these problems and I point them out here for precautionary reasons. To begin with, relationships of genera and diagnostic characters for them are not discussed in Graham's text. Although genera are apparently arranged in a phylogenetic system within the text, there is little or no discussion of relationships between them. To *define* genera it is therefore necessary to search through the keys for useful characters. However, when one does this for well-known genera with large numbers of species, such as *Chlorocytus* Graham, *Pteromalus* Swederus, and *Mesopolobus* Westwood (ca. 120 species total), it is apparent that they are not clearly defined. For example, these 3 genera run to 24 different couplets in the key. The conclusion one draws from this is that species grouped in each of these genera cannot be defined by shared, unique characters (i.e., synapomorphies). A more serious problem is that a large proportion of genera (54 of 128 Palearctic genera) are represented by only 1 species each and that these genera are often distinguished by a character (or combination of characters) which would be only of specific value in one of the larger three genera listed above. For example, characters associated with pronotal collar, clypeus, flagellomere ratios, color, and abdominal shape may be used to distinguish groups of species within genera (via numerous couplets in the key) as well as to define genera with single species.

The 4 species which I place in *Boharticus,* new genus, serve to illustrate the rather poor definitions and lack of understanding we have within the Pteromalidae. Running these species individually through Graham's key results in one being placed in *Dinotiscus* Ghesquiere, two being placed in *Rhopalicus* Foerster, and one being placed in *Trychnosoma* Graham. For reasons I will discuss under the description of *Boharticus,* I believe the species of this genus represent a natural grouping based upon thoracic and host-related characters. However, the act of defining *Boharticus* causes the distinctions between *Dinotiscus* and *Rhopalicus* to become unclear. That is, the latter two genera now are defined by characters which appear to be more appropriate for separating species. At present, I can do little to resolve the generic problems between *Rhopalicus* and *Dinotiscus.* Although I have seen all the species of these genera and I have provided a modification of Graham's key which will separate them, their true status will require a major taxonomic revision of the entire family. Such a revision will require analysis of new sets of characters (such as the thoracic characters used to define *Boharticus*) as well as reexamination of previously used ones.

Bohарticus Grissell, New Genus

Type-species.—Boharticus richardi Grissell, new species.

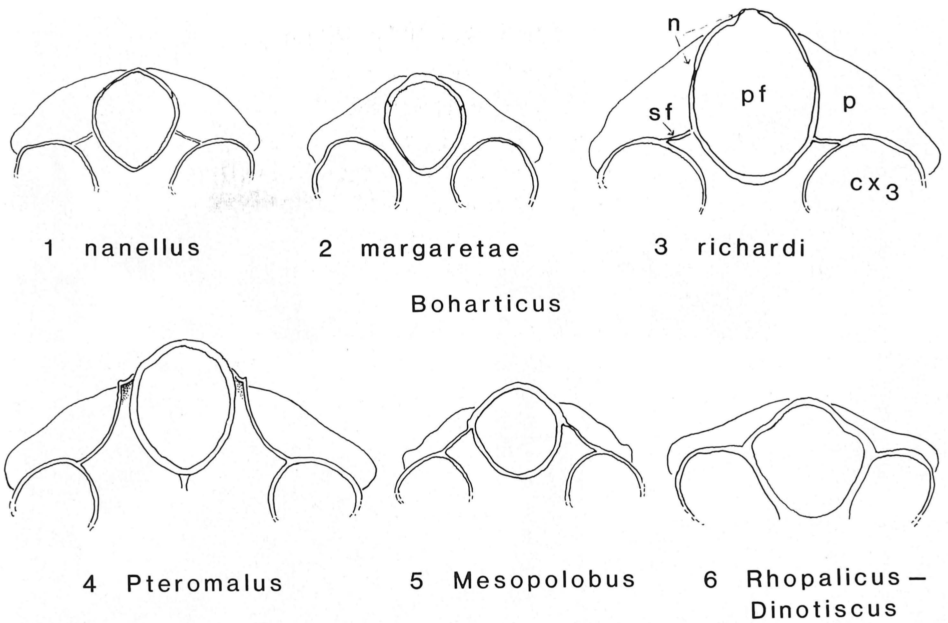
Occiput without carina; clypeus entire; lower face not protuberant at level of toruli; antenna with 2 anelli, 6 flagellomeres, and 3 segmented club; torulus 2 to 3 diameters above level of ventral margins of eyes; both mandibles with 3 denticles, uppermost denticle truncate. Almost entire thorax similarly and heavily reticulate including postalar plate (Fig. 12), upper epimeron, dorsellum, and propodeum; scutum with notauli on anterior half; frenum weakly indicated by finer sculpture on area anterior to it; dorsellum well developed (i.e., not narrowed or reduced) and protruding at least as far as apex of scutellum, not separated from scutellum by costate groove; propodeum with or without complete median carina, without plicae or costula; nucha represented by narrow, lunate strip which may be triangularly enlarged medially in some species (e.g., Fig. 11); supracoxal flange not joined to nucha (but may be joined to inner one-third of petiolar foramen, Figs. 1, 3); hindcoxa with or without setae dorsally; forefemur not enlarged or emarginate ventrally; hind tibia with one apical spur; forewing with maculae, postmarginal and marginal veins longer than stigmal, postmarginal equal to or shorter than marginal, stigma not enlarged. Gaster lanceolate, petiole transverse and scarcely visible, terga entire on posterior margins, bristles of cerci equal in length, ovipositor not exserted, tip of hypopygium not (or barely) reaching middle of gaster.

Etymology.—Named in honor of Richard M. Bohart on the occasion of his 70th birthday. The gender is masculine.

Discussion.—The genus *Boharticus* is recognized as monophyletic based upon the following synapomorphies:

1) All species share a structurally unique thorax as follows:
   a) On the propodeum in dorsal view, the area between the nucha and the supracoxal flange is not connected by a carina (thus the propodeum appears to turn under at this point). In *B. margaretae* this connecting carina is absent (Fig. 2). In *B. richardi, nanellus,* and *apilosus,* however, the carina curves around the inner margin of the coxal cavity and joins the propodeal foramen in the inner one-third (Figs. 1, 3; compare this with Fig. 6 for *Rhopalicus* and *Dinotiscus*);
   b) The thorax is heavily and similarly reticulate on nearly every surface, but especially on the upper epimeron, the dorsellum, the postalar plate (Fig. 12), and the propodeum.
2) All species are associated biologically with gall-formers on the plant genus *Juniperus.* The gall-formers are known to be Cecidomyiidae for 3 species of *Boharticus.* The fourth species is known only from juniper "berries," but this is probably an error in identification because the galls of several cecidomyiids (e.g., *Walshomyia*) resemble fruiting structures.

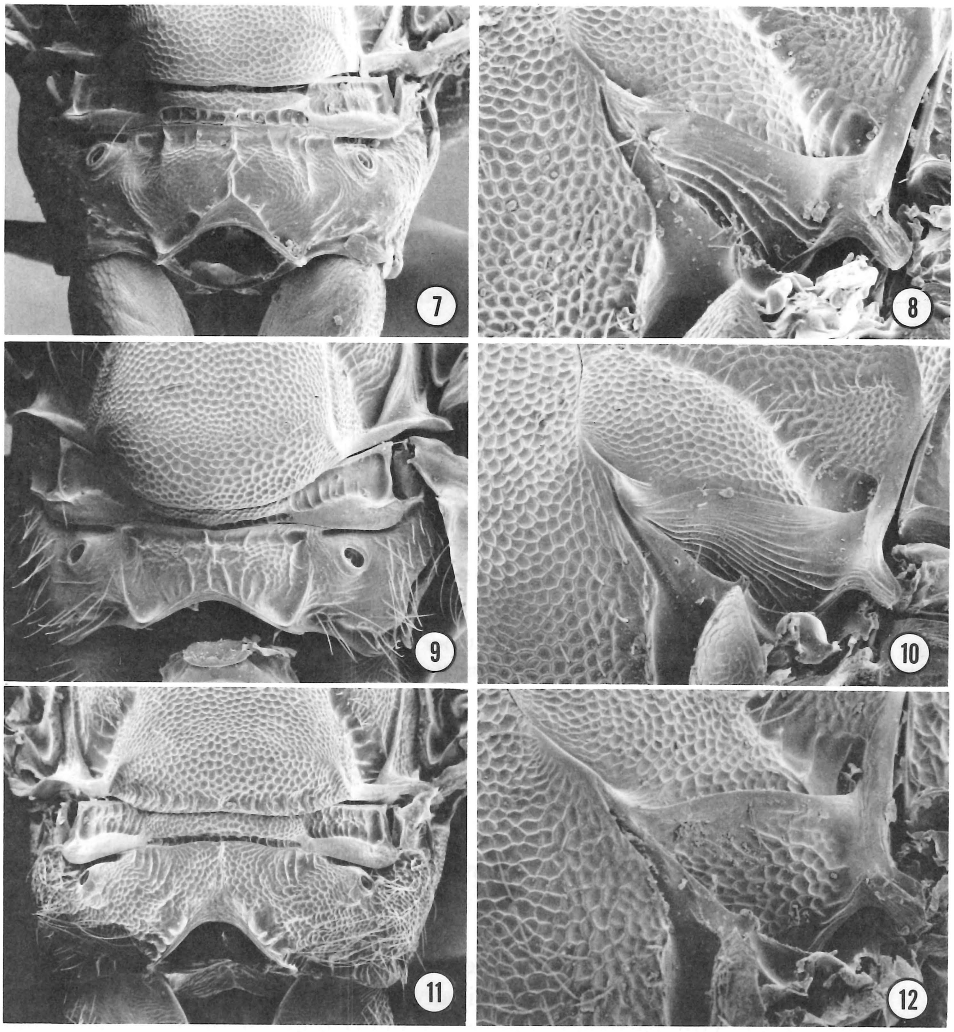
If the members of *Boharticus* are placed within the context of Graham (1969), 3 of the 4 species would key to couplet 205 which includes *Dinotiscus* and *Rhopalicus,* and the fourth would key to *Trychnosoma* Graham (couplet 110; for discussion see *B. apilosus* below). *Boharticus* differs from both *Rhopalicus* and *Dinotiscus* as follows:



Figs. 1–6. Ventral view of propodeum and posterior apex of thorax (*cx*3 = hindcoxal foramen; *n* = nucha; *p* = propodeum; *pf* = propodeal foramen; *sf* = supracoxal flange).

1) All species of these latter 2 genera (as well as other related Pteromalinae genera) share the following thoracic characters:
   a) In dorsal view, the supracoxal flange is connected to the nucha by a carina (ventrally the carina may be seen to join the nucha in the outer one-third, Fig. 6);
   b) The thorax is not everywhere heavily or evenly reticulate; at least the postalar plate (Figs. 8, 10) is vertically carinate (may be smooth on outer margin or with vertically elongate reticulations on inner margin), the upper epimeron and/or dorsellum may be smooth, and the propodeum is less heavily sculptured than the apex of the scutellum.
2) All species of these genera are parasitic upon wood-infesting beetles of the families Scolytidae and Curculionidae.

The propodeal character involving the supracoxal flange is not the easiest of characters to interpret, and I offer these additional notes as a guideline. Initially, in trying to assess the structure of the flange, it was necessary to remove the abdomen of each specimen for a better view. However, the flange may be seen in dorsal view, without removing the abdomen, by tilting the specimen forward. In genera such as *Dinotiscus* and *Rhopalicus* the flange is easily seen from this position (Figs. 7, 9) partially because it is well developed and partially because it is relatively near to the posterior margin of the propodeum (Fig. 6). In *Boharticus,* the flange is either absent (Fig. 2) or weakly developed and positioned toward the anterior of the propodeal foramen (Figs. 1, 3). In ventral view, and with the



Figs. 7–12. Scanning electron micrographs. 7, 8, *Rhopalicus pulchripennis.* 9, 10, *Dinotiscus thomsoni.* 11, 12, *Boharticus richardi.* (Left, propodeum; right, postalar plate.)

abdomen removed, the supracoxal flange of *Rhopalicus* and *Dinotiscus* is continuous with the nucha and there is virtually no sclerite between the propodeal foramen and the hindcoxal foramen (Fig. 6). In *Boharticus,* however, the supracoxal flange (if present) does not join the nucha, but instead joins the propodeal foramen and there is a sclerotized area between the propodeal and hindcoxal foramina (Figs. 1–3).

It is not known how useful this character will be throughout the Pteromalinae. However, in examining many species of *Mesopolobus* Westwood, which share the narrowed nucha of *Boharticus, Dinotiscus,* and *Rhopalicus,* it was found that the character was stable for the genus, although it was expressed in a manner intermediate (Fig. 5) to *Boharticus* (Fig. 1–3) and *Rhopalicus-Dinotiscus* (Fig. 6). In

Mesopolobus there is a sclerotized area between the foramina (as in *Boharticus*) but the supracoxal flange joins the nucha (as in *Rhopalicus-Dinotiscus*). In *Pteromalus,* a genus separated from the above mentioned genera by virtue of an elongate, sculptured nucha, the supracoxal flange is also consistently well developed, elongate, and joins the nucha as in *Mesopolobus* (cf. Figs. 4 and 5). This character is constant for the species of *Pteromalus* I have examined.

For practical purposes the following couplets are proposed to replace those numbered 205 to 206 in Graham (1969:387). This replacement is based upon all known species of *Boharticus, Dinotiscus,* and *Rhopalicus.*

205 (53, 124) Hindtibia with 2 apical spurs (Palearctic) .. *Acrocormus* Foerster
– Hindtibia with 1 apical spur 206
206 (205) Nearly entire thorax similarly and heavily reticulate (note especially postalar plate (Fig. 12), upper epimeron, dorsellum, and propodeum); supracoxal flange not joined directly to nucha (Figs. 1–3; may be joined to lower third of propodeal foramen), in dorsal view flange not easily seen ....*Boharticus* Grissell
– Thorax not similarly reticulate throughout, postalar plate vertically carinate (Figs. 8, 10; may appear elongately reticulate towards inner margin and smooth along outer), epimeron may be smooth above, propodeum alutaceous medially or at least less heavily sculptured than apex of scutellum; supracoxal flange joined to nucha and visible in dorsal view (Figs. 7, 9) 207
207 (206) Pronotum carinate; propodeal nucha medially a semicircular, narrowed carina (Fig. 9) .... *Dinotiscus* Ghesquiere
– Pronotum without carina; propodeal nucha medially expanded as triangular area (Fig. 7) .... *Rhopalicus* Foerster

Key to Female *Boharticus*

1. Basal cell of forewing essentially bare (with 0 to 10 setae, but if questionable then wing spot parallels marginal vein and parastigma (Fig. 16)); pronotal collar carinate 2
– Basal cell of forewing fairly evenly setose (usually over 10 setae, but if questionable, as in some specimens less than 1 mm, then wing spot confined to stigmal area, Fig. 14); pronotum without carina 3
2. Hindcoxa with basal setae; forewing with maculae expanded at both stigmal and parastigmal areas (Fig. 13) .... *margaretae* Grissell, n. sp.
– Hindcoxa without basal setae; forewing with macula expanded only at stigmal area (Fig. 16) .... *apilosus* Grissell, n. sp.
3. Forewing macula surrounding stigmal vein and paralleling marginal vein (Fig. 15); abdomen about 3× as long as wide; nucha expanded medially as carina which reaches (or nearly) dorsum of propodeum (Fig. 11) ... . *richardi* Grissell, n. sp.
– Forewing macula restricted to stigmal area (Fig. 14); abdomen less than 1.5× as long as wide; nucha parallel-sided medially, not extending dorsally as carina .... *nanellus* Grissell, n. sp.

Boharticus richardi Grissell, New Species
(Figs. 3, 11, 12, 15, 19)

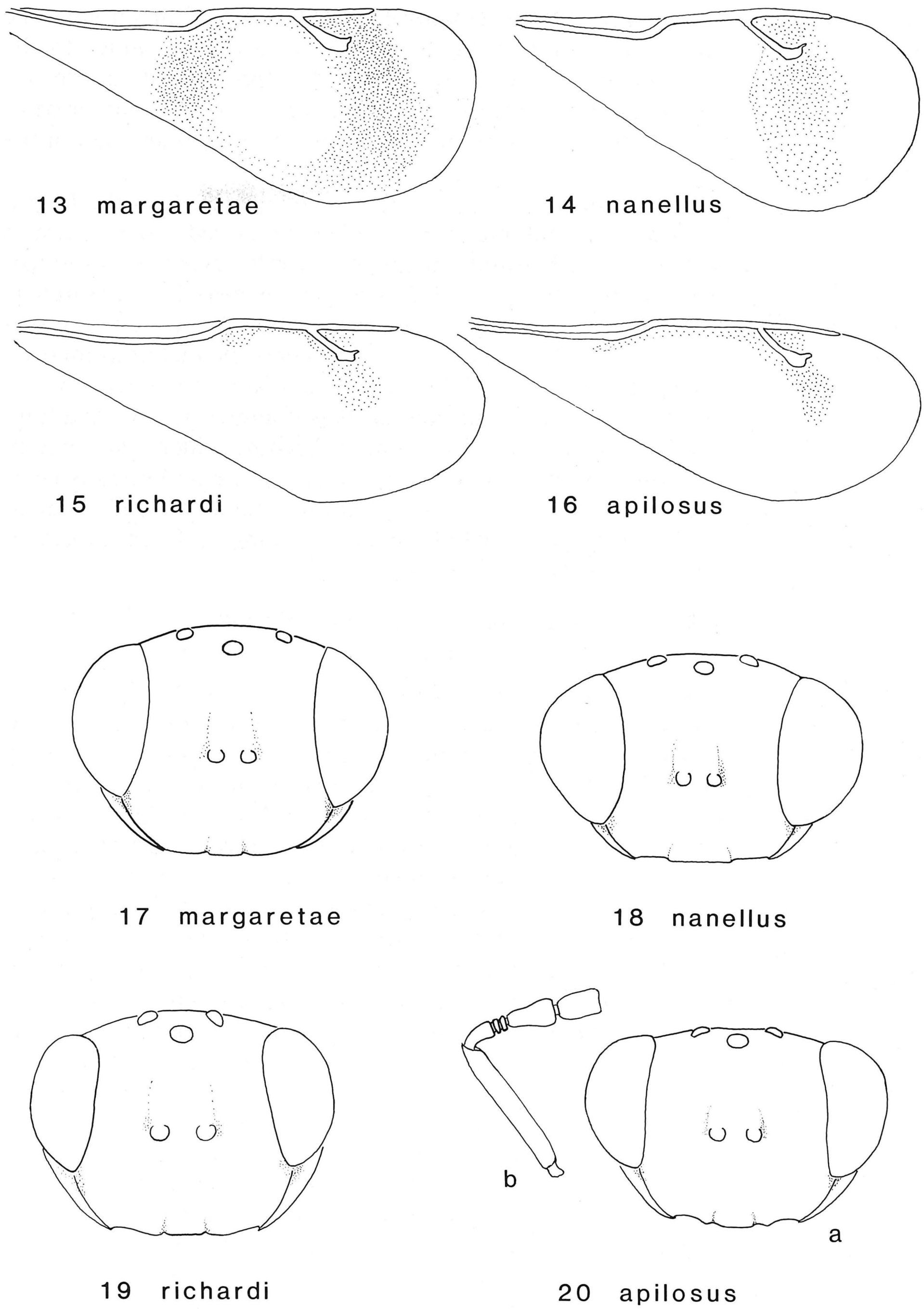
Holotype female.—Body length 5.8 mm. Head and thorax (excluding legs beyond coxae) metallic green; abdomen metallic red with green reflections; femora and tibiae smoky orange; scape, tegula, and tarsomeres 1–4 straw-yellow; antenna and tarsomere 5 brown, wing veins brown becoming slightly lighter towards postmarginal. Head, thorax, and abdomen (except posterior margin of terga nearly smooth) with reticulate sculpture. Face as shown in Fig. 19; toruli 2× own diameter above ventral margin of eyes (5:10); intermalar distance 2.1× malar distance (32:15); eye 2.3× length of malar distance (34:15); ratio of lateral ocellus diameter : ocellocular distance : postocellar distance as 5:10:14; ratio scape : pedicel : anelli : flagellomeres 1–6 : club as 50:14:3:3:17:16:16:14:13:13:27, flagellomeres starting 1.6× as long as wide (F1 = 16:10) and becoming as long as wide (F6 = 13:13). Pronotal collar not margined anteriorly, dropping almost perpendicularly to neck; nucha angled medially forming an acute triangle which narrows and continues to dorsal margin of propodeum (Fig. 11); basal fovea about size of spiracle and midway between spiracle and median carina, apical fovea about as large as basal one, 10–15 setae present posterior to spiracle, callus evenly setose; epimeral scrobe nearly straight, situated at midpoint of epimeron and occupying about 1/7 of length; wing veins with ratio of submarginal : marginal : postmarginal : stigmal as 48:16:16:10; basal cell with at least 25 setae, setae present on cubital and basal veins, costal cell with complete anterior setal row beneath and several rows beneath on distal 1/3; maculations as shown in Fig. 15; hindcoxa with setae basally. Abdomen keel-shaped (i.e., somewhat laterally compressed but dorsally flat), with heavy, reticulate sculpture, with ratio of T1–7 : ovipositor sheaths as 15:10:8:8:12:17:15:3; ratio length : width as 43:14; ratio abdomen : thorax as 43:23.

Male.—Unknown.

Type material.—Holotype ♀, USNM #100592; CALIFORNIA, *Fresno Co.,* Coalinga, 21 March 1960, H. L. Wilson, ex Juniper galls. Paratypes: 7 ♀, same data as holotype; 1 ♀, same data except 20 March 1959, ex "Juniper berries;" 3 ♀, CALIFORNIA, *Los Angeles Co.,* Vasquez Rocks, 25 January 1963, ex pinecone gall on *Juniperus californica*; 2 ♀, CALIFORNIA, *Stanislaus Co.,* Del Puerto Canyon, E. E. Grissell, R. F. Denno, em. 15 March 1971 ex cecidomyiid cone gall on *Juniperus californica* collected 6 March 1971. All specimens in USNM except 2 ♀ in British Museum (Natural History). (The "pine-cone" gall is made by a species of Cecidomyiidae in the genus *Walshomyia* according to R. J. Gagne, personal communication. The juniper "berry" record is probably a mistake, as some *Walshomyia* galls have the appearance of a fruiting structure.)

Etymology.—Named for Richard M. Bohart, mentor, colleague, and friend.

Variation.—Females of *B. richardi* range in length from 4.9 to 6.2 mm. Color of the head and thorax is metallic green in most specimens (15) but 1 specimen is metallic blue. The abdomen is metallic red in 13 specimens and metallic green tinged red in 2. The maculation pattern of the forewing is consistent, but the intensity varies from very dark brown (with distinct edges) to a washed out brown (with indistinct edges, i.e., the pattern fades into the surrounding clear areas). The number of setae of the basal cell is variable, but the cell is fairly evenly covered with 20 or more setae. All the specimens have the nucha extended dorsally as a keel or carina, but in 2 specimens this carina fades toward the dorsal propodeal



Figs. 13–20. *Boharticus* n. spp. 13–16, forewing (setae not shown). 17–20, face, frontal view; 20b, scape, pedicel, anelli, flagellomeres 1 and 2.

margin and does not reach it. The specimens from Del Puerto Canyon have the nucha less pronounced than other specimens, but the carina continues to the propodeal margin. The basal fovae very from a simple depression about the size of the spiracle to a depression several times as large with 2 or 3 carinae present. The epimeral scrobe may be short as in the holotype or it may occupy half of the epimeral length.

Discussion.—This is the most striking member of the genus. It is the largest species (to over 6 mm), and the abdomen is generally metallic red which contrasts distinctly with the green thorax. The abdomen is considerably elongate (3× longer than wide, 2× longer than the thorax), keel-shaped, and as heavily sculptured as the thorax. Although *richardi* shares the setose basal cell with *nanellus,* the two do not appear particularly related. They differ in a number of characters as follows: in *richardi* the eye height is less than 2.5× the malar distance (nearly 3.5× in *nanellus*), F1 is over 1.5× longer than wide and the flagellomeres become quadrate at F6 (F1 is quadrate in *nanellus,* and flagellomeres become wider than long by F6), the fore and midcoxae are green (yellow in *nanellus*), the abdomen is keel-shaped and flat dorsally with heavy, reticulate sculpture (dorso-ventrally sunken in *nanellus*), and T1 and 7 are subequal (T1 is 2.5× as long as T7 in *nanellus*). Additional characters may be found in the key.

Boharticus margaretae **Grissell, New Species**
(Figs. 2, 13, 17)

Holotype female.—Body length 3.0 mm. Head and thorax (excluding legs beyond coxae) metallic green; abdomen blackish purple; femora, tibiae, and tegula, smoky orange; scape and tarsi straw-yellow; antenna and wing veins brown, forewing with 2 brown spots. Head, thorax, and abdomen (except posterior margins of terga smooth) covered with reticulate sculpture. Face as shown in Fig. 17; toruli 2.7× own diameter above ventral margin of eyes (6:16); intermalar distance 2.3× malar distance (21:9); eye 2.9× length of malar distance (26:9); ratio of lateral ocellus diameter : ocellocular distance : postocellar distance as 6:12:21; ratio scape: pedicel : anelli : flagellomeres 1–6 : club as 40:14:2:2:10:9:9:9:9:8:17, flagellomeres starting slightly longer than wide (F1 = 9:7) and becoming slightly wider than long (F6 = 9:8). Pronotal collar margined anteriorly, dropping almost perpendicularly to the neck, collar laterally rounded off; nucha evenly curved and parallel-sided medially, disappearing at lateral edges, basal foveae essentially absent, apical fovea well developed, 3 or 4 long setae present posterior to inner margin of spiracular sulcus, callus with about 5 setae; epimeral scrobe a long, crescentric groove reaching from near posterior margin to anterior margin; wing veins with ratio of submarginal : marginal : postmarginal : stigmal as 45:21:19:14; basally, cubital and basal veins without setae, wing essentially bare from speculum to base (only a few setae present near intersection of cubital and basal veins, and costal cell with anterior row beneath); maculations as shown in Fig. 13; hindcoxa with setae basally. Abdomen keel-shaped, dorsally flattened, with reticulate sculpture, with ratio T1–7 : ovipositor sheaths as 12:12:14:13:10:8:7:6; ratio length : width as 40:18; ratio abdomen : thorax as 40:26.

Male—Unknown.

Type material.—Holotype female, USNM #100593; COLORADO, *El Paso Co.,* Garden of the Gods, 20 July 1915, J. H. Pollock, [ex "cecidomyiid larvae in old buds"], *Juniperus monosperma,* "Hopkins U. S. 12946a." Paratypes: 8 ♀, same data as holotype; 1 ♀, ARIZONA, *Mohave Co.,* 8 miles SW Peach Springs, 4500′, 7 September 1964, C. W. O'Brien, ex *Juniperus.* All specimens in USNM, except 1 ♀ in British Museum (Natural History). (Note: The bracketed material above was taken from Hopkins cards on file at the USNM; according to these cards, the gall material was collected on 1 July 1915 and parasites emerged on 20 July.)

Etymology.—This attractive little species is named for Margaret Bohart who, for many years, has shown much generosity and hospitality to Dick's students.

Variation.—Females vary from 2.3 to 2.7 mm. The thorax varies from metallic green to metallic blue. The wing maculations are equally intense on all of the specimens. On several specimens the basal foveae are indicated by a slight depression bordered on the inner side by a short carina; the pit is equal in size or smaller than the spiracle.

Discussion.—This species is similar to *apilosus* in having the basal cell of the forewing nearly asetose and in the carinate pronotum. There are rather striking differences between the species especially in forewing maculations and hindcoxal setae (as stated in the key). The flagellomeres of *margaretae* range from barely longer than wide (F1) to wider than long (F6), whereas in *apilosus,* F1 is nearly 2× as long as wide and F6 is longer than wide. Also in *margaretae* F1 is cylindrical but in *apilosus* it is constricted basally (Fig. 20b). Additionally, the abdomen of *margaretae* is rigid with dull reticulate sculpture somewhat as on the thorax, but in *apilosus* the abdomen is distorted and sunken with shiny, alutaceous sculpture.

Boharticus nanellus **Grissell, New Species**

(Figs. 1, 14, 18)

Holotype female.—Body length 1.7 mm. Head, thorax, and upper ¾ of hindcoxa metallic green; yellow are: scape, fore and midcoxae (and apex of hindcoxa), legs (except tarsomere 5 dark brown), and abdomen (which is smoky dorsally); wing veins and tegula straw colored; flagellum brown. Head and thorax evenly covered with reticulate sculpture; abdomen evenly covered with reticulations but not as raised as on thorax (also difficult to see with reflected light because of yellow background). Face as shown in Fig. 18; toruli nearly 3× own diameter above ventral margin of eyes (4:11); intermalar distance 2.4× malar distance (22:9); eye 2.4× length of malar distance (22:9); ratio lateral ocellus diameter : ocellocular distance : postocellar distance as 5:10:15; ratio scape : pedicel : anelli : flagellomeres 1–6 : club as 23:8:1:1:5:5:4:4:5:5:12, flagellomeres starting 1× as long as wide (F1 = 5:5) and becoming wider than long (F6 = 6:5). Pronotal collar in dorsal view dropping perpendicularly to the neck but without carina; nucha a narrow carina which is scarcely widened medially, basal and apical fovae about the size of spiracle (not very well developed); 2 or 3 long setae present posterior to spiracle, callus with about 5 or 6 setae; epimeral scrobe poorly defined, situated at midpoint of epimeron and occupying about $1/7$ the length; wing veins with ratio of submarginal : marginal : postmarginal : stigmal as 55:30:28:20; wing heavily setose with areas bare as follows: speculum, area beneath cubital vein, basal half of costal cell (except row of setae along lower foremargin); maculations as shown in Fig. 14, weakly expressed and diffuse; hindcoxa with several setae basally. Abdomen dorsoventrally sunken, with ratio T1–7 : ovipositor sheaths as 16:12:10:10:11:14:6:1; ratio length : width as 40:32; ratio abdomen : thorax as 40:33.

Allotype male.—Body length 1.5 mm. Color as for female except abdomen metallic reddish. Similar to female (including ratios) except as follows: flagellomeres with recurved setae which are about as long as segment; wing maculation restricted to weak stain posterior to stigma; ratio T1–6 as 14:5:4:4:3:2.

Type material.—Holotype female, USNM #100594; OHIO, *Wayne Co.*, Wooster, 25 June 1961, J. E. Appleby, ex tip midge on *Juniperus horizontalis.* Allotype ♂, 1 ♀, 2 ♂ paratypes same data as holotype; 1 ♀, 1 ♂ paratype same data as holotype except ex *Juniperus virginiana*; 63 ♀, 66 ♂ paratypes, FLORIDA, *Alachua Co.*, Gainesville (Doyle Conner Building), 15–26-XI-1973, E. E. Grissell, sweeping *Juniperus salicicola* (Small) Bailey. Holotype ♀ and paratypes from Ohio in USNM; paratypes from Florida in FSCA, USNM, BMNH, and the Canadian National Collection, Ottawa.

Etymology.—From the diminuative (*-ellus*) of *nanus*—a dwarf, in reference to the small size of this species.

Variation.—Males and females from the Ohio population are generally larger in size than the Florida population. Males from Ohio range in length from 1.3 to 1.5 mm and females are about 1.6 mm long. Females from Florida, however, range in size from 0.8 to 1.5 mm and males from 0.7 to 1.0 mm. The wing maculation varies considerably even within the 3 females from Ohio. In the holotype and 1 female from *J. virginiana* the forewing spot is weak and occupies the anterior half to third of the wing; in 1 female from *J. horizontalis* the spot nearly reaches the hindmargin of the wing (but with a hyaline break at one-third the distance from the posterior margin). Larger females from Florida (ca. 1.5 mm) have the wing spot as for the holotype, but small females (ca. 0.8 mm) have the spot restricted to a weak stain posterior to the stigma. In males the spot resembles that of small females or is absent. In general, as the specimens become smaller (either sex), the yellowish coloring of the abdomen and hindcoxae becomes darker. The mid and forecoxa, legs, and scape remain yellow even in the smallest male. In small specimens, the number of setae in the basal cell is reduced to about 10, but the setae are fairly evenly spaced. In both males and females, the epimeral scrobe may be absent regardless of the size.

Discussion.—This is the smallest species of the genus, being less than 2 mm, and the only species for which the male is known. For a discussion see *B. richardi.*

Boharticus apilosus **Grissell, New Species**
(Figs. 16, 20)

Holotype female.—Body length 3.2 mm. Head and thorax metallic green; scape and abdomen blackish green; legs yellowish orange except femora with greenish reflections, tibiae smoky, foretarsi and mid and hind tarsomeres all darkish brown; antennae, wing veins, and wing maculation brown. Head and thorax evenly covered with reticulate sculpture; abdomen alutaceous. Face as shown in Fig. 20a; toruli 2× own diameter above ventral margin of eyes (3:6); intermalar distance 2.1× malar distance (19:9); eye 2.6× length of malar distance (42:16); ratio of lateral ocellus diameter : ocellocular distance : postocellar distance as 3:6:9; ratio scape : pedicel : anelli : flagellomeres 1–6 : club as 36:10:2:2:11:13:12:12:12:10:20; flagellomeres starting ca. 2× longer than wide (F1 = 11:6) and remaining longer than wide (F6 = 10:8); F1 constricted at base (Fig. 20b). Pronotal collar dropping perpendicularly to the neck, with carina along anterior margin; nucha a narrow carina which is slightly produced medially to form frail carina which reaches half way to anterior margin of propodeum, basal and apical foveae about size of spiracle (not well developed); ca. 6 long setae present posterior to spiracle, callus with about 10 setae; epimeral scrobe a long, crescentric line reaching from posterior margin to anterior; wing veins with ratio of submarginal : marginal : postmarginal : stigmal as 45:30:25:18; basal cell with 6 to 8 setae, speculum and area below cubital vein bare, costal cell with row of setae along anterior margin on underside and 2 sparse rows in distal ⅓ on underside; maculations as shown in Fig. 16; hindcoxa without setae basally (2 or 3 setae distally). Abdomen keel-shaped, dorsally sunken due to lightly sclerotized terga, with ratio T1–7 : ovipositor sheaths as 18:6:19:9:16:15:9:6; ratio length : width as 49:15; ratio abdomen : thorax as 49:25.

Male.—Unknown.

Type material.—Holotype ♀, USNM #100595; ARIZONA, *Santa Cruz Co.,* Patagonia, 3 October 1946, Nog. #65320, ex "*Juniper berries.*" Paratypes: 5 ♀, same data as holotype. All specimens in USNM.

Etymology.—From *pilosus*—hairy and *a*—without, in reference to the lack of setae on the base of the hindcoxa.

Variation.—The number of setae in the basal cell ranges from 4 to 8. The abdomen of the type is distorted so that T2 and T4 appear shorter than for other specimens. From the specimens at hand, T2–6 may be subequal, or T2 and T4 may be equal and shorter than T3, T5, and T6. The abdomen of this species is weakly sclerotized and tends to shrivel.

Discussion.—*Boharticus apilosus* is the only species of the genus with the first flagellomere constricted basally (Fig. 20b), and also the only one with no setae on the base of the hindcoxa. For additional characters see *B. margaretae.*

Because of the lack of setae on the hindcoxa, this species would key to the genus *Trychnosoma* Graham in Graham's key (1969) to the European Pteromalidae. It differs from that genus, however by the following: 3 denticles in both mandibles (4 on right mandible of *Trychnosoma*), clypeus reticulate (radiating striae in *Trychnosoma*), forewing with maculations (hyaline in *Trychnosoma*), and the supracoxal flange not joining the nucha (joining in *Trychnosoma*).

Rhopalicus Foerster

Rhopalicus Foerster, 1856:66, 70.

Type-species: *Cleonymus maculifer* Foerster, 1840. Monotypic.

This genus is known from 4 species as follows: *tutela* (Walker) is Holarctic, *pulchripennis* (Crawford) is primarily confined to the northern Nearctic, and *brevicornis* Thomson and *guttatus* (Ratzeburg) are Palearctic. A fifth species is herein described as new and is found throughout the southeastern Nearctic. *Rhopalicus* may be defined as follows: clypeus emarginate, with 2 well-defined lobes (Figs. 21a, 22a); venter of torulus less than own diameter above line connecting ventral margins of eyes or slightly below; pronotum without carina; thorax not similarly reticulate throughout, at least postalar plate vertically carinate (may appear elongately reticulate towards inner margin and smooth along outer), epimeron may be smooth above, propodeum nearly shiny or alutaceous medially (but as reticulate as scutellum in *zolae* and some *pulchripennis*); nucha medially expanded as triangular area which narrows to median carina and meets (or nearly) anterior margin of propodeum (Fig. 7); supracoxal flange joined to nucha (as in Fig. 6); forewing with or without maculations; postmarginal and marginal veins longer than stigmal, and postmarginal at least slightly longer than marginal, stigma not enlarged in female, but may be elongate as in Fig. 24c (in male slightly enlarged in *tutela*, Fig. 24a).

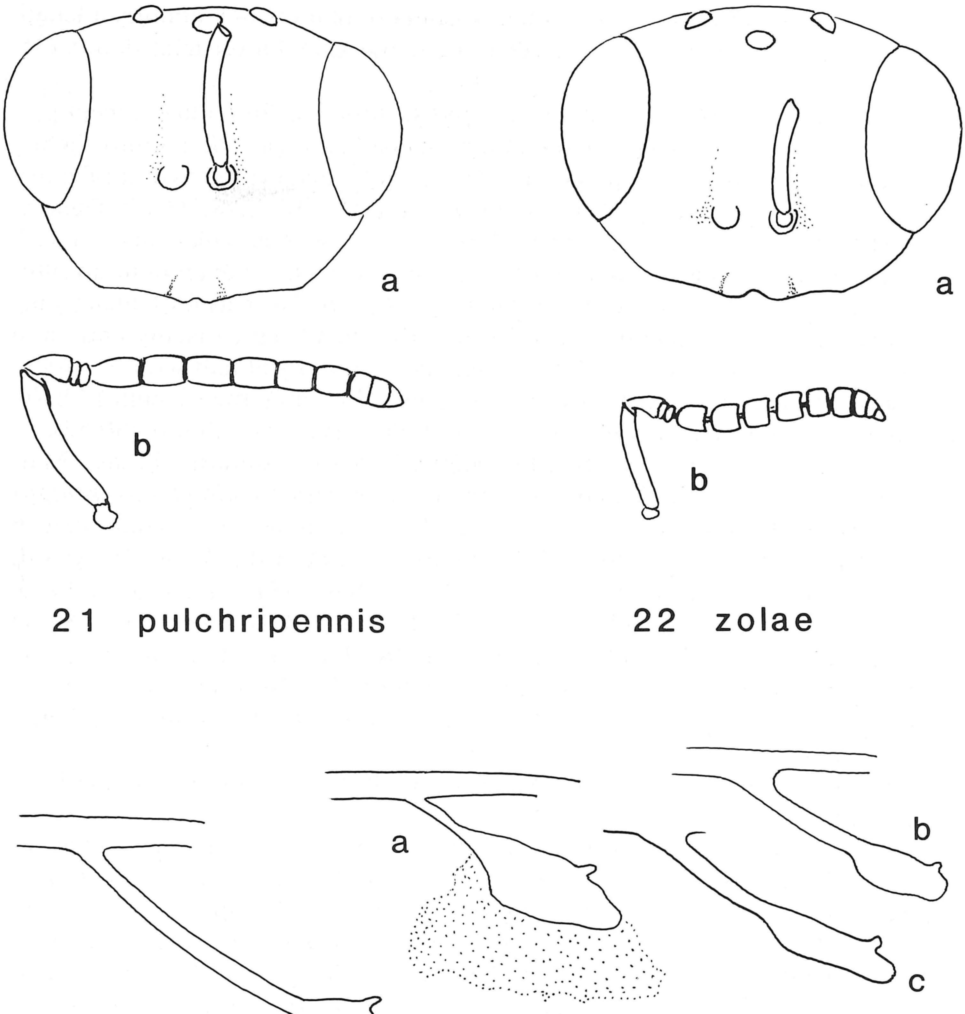
My concepts of the species discussed below are based upon Graham's work (1969: extant types examined), my identification of Palearctic specimens based upon his key, the types of the Nearctic species, and the lectotype of *tutela* (Walker) (BMNH).

Key to Female *Rhopalicus*

1. Lower surface of forewing costal cell with 2 or more rows of setae in proximal half; upper epimeron smooth; macula of wing (rarely absent) associated with stigma (Holarctic) .... *tutela* (Walker)
– Lower surface of forewing costal cell with 1 row of setae in proximal half; upper epimeron similarly reticulate to lower portion; macula of wing absent or associated with marginal vein 2
2. Scape length at most ¾ distance between top of torulus and venter of midocellus (Fig. 22a); basal vein without setae (Nearctic) .... *zolae* Grissell, n. sp.
– Scape length subequal to distance between top of torulus and venter of midocellus (Fig. 21a); basal vein with setae 3
3. Forewing hyaline; flagellomeres 1–6 together shorter than distance between eyes (dorsal view) (Palearctic) .... *quadratus* (Ratzeburg)
– Forewing with some form of spot; flagellomeres 1–6 together longer than distance between eyes 4
4. Forewing with infumate spot confined to basal half of marginal vein; dorsellum separated from scutellum by pitted groove (Palearctic) .... *guttatus* (Ratzeburg)
– Forewing with infumate spot beneath entire length of marginal vein; dorsellum continuous with scutellum (at most a weak line delimits the suture) (Nearctic) .... *pulchripennis* (Crawford)

Rhopalicus zolae **Grissell, New Species**
(Fig. 22)

Holotype female.—Body length 2.7 mm. Head and thorax metallic blue-green; legs, apices of fore and midcoxae, and scape concolorus golden-yellow; flagellum, tegula, and abdomen dark brown; base of fore and midcoxae and entire hindcoxa metallic blue to violet; submarginal and stigmal veins brownish white, marginal, postmarginal, and stigma pale brown. Head and thorax nearly evenly covered with reticulate sculpture (except postalar plate vertically carinate); abdomen weakly sclerotized and shriveled, polished to faintly alutaceous. Face as shown in Fig. 22a; torulus slightly below line connecting ventral margin of eyes; intermalar distance nearly 2× malar distance (17:9); eye 2.3× length of malar distance (21:9); ratio of lateral ocellus diameter : ocellocular distance : postocellar distance as



Figs. 21–24. *Rhopalicus* spp. 21, 22, a = face, frontal view; b = antennae, side view (to same scale as face). 23, 24, stigma and stigmal vein of forewing. 24, a = male; b, c = female showing variation.

6:12:22; ratio scape : pedicel : anelli : flagellomeres 1–6 : club as 26:9:1:2:9:8:7:7: 6:6:10, flagellomeres starting 1× as long as wide (F1 = 9:9) and becoming 0.6× as long as wide (F6 = 6:10); F1–6 0.9× distance between eyes dorsally (44:50); scape 0.72× as long as distance between top of toruli and venter of midocellus (26:36) and 0.65× eye height (26:40). Thorax dorso-ventrally flattened, scutellum and scutum in same plane, propodeum with complete median carina; wing veins with ratio of submarginal : marginal : postmarginal : stigmal as 43:16:21:15; basal cell, basal vein, and cubital veins without setae, costal cell with complete anterior row below, and distal half with 1 additional row; weakly defined pale brown spot present below marginal vein. Abdomen with first tergum 0.14× abdomen length (7:35), abdomen 1.5× longer than wide (35:23) and 1.5× longer than thorax (35:23).

Allotype male.—Length 2.3 mm. Color and sculpture as for female, except pale yellow band present on distal half of tergum I and all of tergum II. Torulus slightly above a line connecting ventral margins of eyes; malar and eye ratios as for female; ratio scape : pedicel : anelli : F1–F6 : club as 30:10:1:2:10:9:8:8:7:7:17; flagellomeres starting 1.4× as long as wide; F1–6 1.13× least interocular distance (27:24); scape 0.84× as long as distance between top of toruli and venter of midocellus (26:31) and 0.70× eye height (26:37). Thorax and propodeum as for female; wing veins with same ratio as female, basal cell with several setae distally and basal vein with row of setae, costal cell as for female except distal half with 3 rows of setae instead of 2. Abdomen with first tergum 0.40× abdomen length (20:50), abdomen 1.7× longer than wide (50:24) and 0.96× as long as thorax (50:52).

Type material.—Holotype ♀ USNM #100695; TEXAS, "Southeast Texas," Mar. 1962 to Oct. 1963, R. C. Thatcher, ex loblolly pine with *Dendroctonus frontalis* Zimmermann. Allotype ♂, 8 ♀ paratypes and 3 ♂ paratypes with same data; 6 paratypes as follows: 1 ♀, MISSISSIPPI, *Amite Co.,* 7 May 1965, N. A. Overgaard, ex pine infested with southern pine beetle; 1 ♀, TEXAS, *Hardin Co.,* June 1960, ex pine infested with *Ips,* Hopkins No. 38912; 1 ♀, GEORGIA, *Dekalb Co.,* Stone Mountain, 26 Oct. 1947, P. W. Fattig; 1 ♀, GEORGIA, *Clark Co.,* Oct. 1965, R. T. Franklin, ex *Ips* infested log of *Pinus echinata*; 2 ♀, NORTH CAROLINA, *Durham Co.,* Durham, 30 May 1942, W. Haliburton, ex *Ips avulsus* LeConte. All specimens in USNM.

Etymology.—Named for my mother who unselfishly supported a young lad's interest in bugs.

Variation.—Females of *zolae* range in length from 2.5 to 3.2 mm. The intensity and size of the forewing maculation varies from an extremely faint stain, confined to the apical fourth of the wing, to a distinct dark spot on the apical fourth which fades gradually and posteriorly to the apical third. The abdomen of all specimens is shriveled, but T1 is about one-sixth the total length and is slightly emarginate posteromedially. In females, the scape ranges from 0.68 to 0.75 times the distance from the top of the toruli to the venter of the midocellus ($n = 10$; $\bar{x} = 0.72 \pm 0.03$); in males the range is 0.84 to 0.87 times the distance ($n = 4$; $\bar{x} = 0.86 \pm 0.01$). In females the length to width ratio of F1 varies considerably and ranges from 0.93 to 1.5 times as long as wide ($n = 10$; $\bar{x} = 1.2 \pm 0.20$). F6 ranges from 0.50 to 0.67 times as long as wide ($n = 10$; $\bar{x} = 0.62 \pm 0.06$). The few males available for study have F1 and F6 relatively longer than females with F1 having a range of 1.4 to 1.7 times longer than wide ($n = 4$; $\bar{x} = 1.5 \pm 0.14$) and F6 0.75 to 0.88 times as long as wide ($n = 3$; $\bar{x} = 0.83 \pm 0.07$).

Distribution.—This species ranges throughout the southeastern United States, from North Carolina south to Georgia and east to Texas.

Hosts.—*Rhopalicus zolae* is associated with pine log rearings usually containing *Ips* and *Dendroctonus frontalis.* One pair of specimens bears the label "ex *Ips avulus,*" but I doubt that the association was actually proven.

Discussion.—Among Nearctic *Rhopalicus, zolae* and *pulchripennis* are superficially similar in appearance. The first species is apparently confined to the southeastern United States, whereas the latter is largely northern in range. The species do overlap, however, and I have seen a few specimens of *pulchripennis* from Texas and Mississippi. I know of at least two instances where *zolae* has been misidentified as *pulchripennis*, and I am certain that some published records for *pulchripennis* actually refer to *zolae*. This is especially true of papers treating the southern pine beetle, *Dendroctonus frontalis* (e.g., Overgaard, 1968; Moser et al., 1971; Berisford, undated). Specimens (in USNM) reared by Overgaard in Mississippi are *zolae*, but they may have been reported as *pulchripennis* in the paper cited above.

The two species are fairly easily distinguished as follows: *zolae* has the length of the scape at most three-fourths that of the distance to the venter of the midocellus ($\bar{x} = 0.72 \pm 0.03$; range 0.68 to 0.75; $n = 10$) (Fig. 22a), whereas *pulchripennis* has the scape essentially as long as the distance to the midocellus ($\bar{x} = 1.1 \pm 0.08$; range 0.93 to 1.2; $n = 10$) (Fig. 21a). This difference is actually a result of the placement of the toruli of *zolae* at a point slightly below a line connecting the ventral margins of the eyes, whereas in *pulchripennis* the toruli are distinctly above such a line. In *zolae* the flagellomeres are generally wider than long (Fig. 22b) and in *pulchripennis* they are generally longer than wide (Fig. 21b), but measurements tend to overlap on small specimens (ca. 3.0 mm) of *pulchripennis*, thus making this character not reliable in every case. In addition, *zolae* has no setae on the basal vein of the forewing, whereas *pulchripennis* has a row of setae present.

Both *zolae* and the Palearctic species *quadratus* share the shortened scape and flagellomeres just mentioned as well as having a dorsoventrally flattened scutum and scutellum (i.e., both essentially in the same plane). In the Palearctic the degree of convexity of the scutellum can be used to separate species (as, for example, *quadratus* from *guttatus*) but in the Nearctic *pulchripennis* varies enough to make the use of this character difficult within the framework of a Holarctic key.

***Rhopalicus quadratus* (Ratzeburg)**
(Fig. 23)

Pteromalus quadratus Ratzeburg, 1844b:203, ♀.
Pteromalus neostadiensis Ratzeburg, 1844b:204, ♀.
Rhopalicus brevicornis Thomson, 1878:43, ♀.

Discussion.—*Rhopalicus quadratus* is the only species with a hyaline forewing. The shortened flagellum (F1–6 shorter than distance between eyes) which separates *quadratus* from *guttatus* and *pulchripennis* is shared with *zolae*, but the two are readily separated by the characters given in the key.

Material examined.—I have seen 37 specimens of this species from Europe (BMNH, USNM).

Distribution.—Northwestern Europe.

Hosts.—Hedqvist (1963:80–81) gave a detailed list of the hosts for this species. All known hosts are Scolytidae of the genera *Tomicus, Carphoborus, Hylurgops, Ips, Orthotomicus, Phloeosinus,* and *Pityogenes.*

***Rhopalicus guttatus* (Ratzeburg)**

Ichneumon (*Pteromalus*) *guttatus* Ratzeburg, 1844a:29 (pl. 8, fig. 5), ♀.

Discussion.—This species and *pulchripennis* share the lengthened flagellum (F1–

6 longer than distance between the eyes) and the convex scutellum. I can find no differences between them except those noted in the key.

Material examined.—Thirteen specimens from Europe determined by Boucek (BMNH) and one determined as a homotype by Ruschka (USNM).

Distribution.—Reported from Britain, Germany, Sweden, and Czechoslovakia (Graham 1969:415), and known additionally from Portugal, Yugoslavia, and Turkey (based upon specimens in BMNH).

Hosts.—Hedqvist (1963:82–83) reported that *guttatus* attacked several species of *Pissodes* (Curculionidae), but he discounted a record for *Ips* (Scolytidae).

Rhopalicus pulchripennis **(Crawford)**
(Figs. 7, 8, 21)

Spintherus pulchripennis Crawford, 1912:168–169, ♀. Holotype ♀, USNM [examined].
Rhopalicus americanus Girault, 1916:296–297, ♀. Holotype ♀, USNM [examined].

Discussion.—Gahan (1924:16) synonymized *americanus* with *pulchripennis.* I agree with this conclusion based upon an examination of the type material. In the Nearctic, *pulchripennis* is the only species to combine both a spot beneath the marginal vein and the presence of setae on the basal vein. For additional remarks see *zolae.*

Material examined.—In addition to the types of *pulchripennis* (7 ♀) and *americanus* (1 ♀), I have examined 123 specimens from North America.

Distribution.—Throughout southern Canada and the northern United States with infrequent (but confirmed) records in Texas, Mississippi, and Virginia.

Hosts.—Recorded from numerous Coleoptera as follows: Scolytidae: *Dendroctonus brevicomis* LeConte, *D. murrayanae* Hopkins, *D. ponderosae* Hopkins, *Pseudohylesinus nebulosus* (LeConte), *Scolytus unispinosus* LeConte; Curculionidae: *Cylindrocopturus eatoni* Buchanan, *C. furnissi* Buchanan, *Pissodes approximatus* Hopkins, *P. strobi* (Peck), *P. terminalus* Hopping. (Records of *pulchripennis* from *Ips* spp. (Overgaard, 1968) and from a combined rearing of *Dendroctonus frontalis* Zimmermann and *Ips* spp. (Moser et al., 1971) probably refer to *Rhopalicus zolae*; see discussion under that species.)

Rhopalicus tutela **(Walker)**
(Fig. 24)

Cheiropachus tutela Walker, 1836b:14–15, ♂, ♀. Lectotype ♀, BMNH [examined].
Cleonymus maculifer Foerster, 1840:34, ♀.
Pteromalus suspensus Ratzeburg, 1844b:189.
Pteromalus spinolae Ratzeburg, 1844b:189, ♂, ♀.
Pteromalus immaculatus Ratzeburg, 1844b:189, 205.
Pteromalus lunula Ratzeburg, 1848:193, ♀.
Pteromalus multicolor Ratzeburg, 1848:193 [n.n. for *P. spinolae* Ratzeburg 1844b: 189, *nec* Foerster, 1840:23].
Pteromalus aemulus Ratzeburg, 1848:203.
Rhopalicus annellus Thomson, 1878:42, ♂, ♀.

Discussion.—*Rhopalicus tutela* is the largest (to 5 mm) and usually most easily distinguished member of the genus based upon the infumate spot associated with